FLIGHT
and
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The Outlook

All Fours

A PERUSAL of the article which we publish in this issue, dealing with the history and development of British four-engined aircraft types, may cause some surprise at the revelation that this country has taken such a leading part in the evolution of this type. In some quarters there seems to be an impression that Great Britain has been backward in this respect. That view can scarcely be sustained after discovering that, during a period of 25 years or so, this country has produced something like 20 different types of four-engined aircraft. At that, our list does not claim to include everything built between 1918 and the present time. For instance, there was the large Fairey N4 *Atalanta*, which was built and flown in 1923. The Fairey company did not go on with flying boat construction, and thus the machine did not become the ancestor of a "family."

There was also the Avro 642, of which only a single example, the *Star of India*, was built for the Viceroy, Lord Willingdon. And there was the ill-fated Tarrant triplane, which crashed on its first take-off, and which had no successors. There are probably others which might have been included, but we have confined our review to the types which have formed a definite part of the history of evolution of the four-engined class.

An interesting fact which emerges from a survey of the last 25 years is that Great Britain has never been very enthusiastic about the tandem arrangement of engines. Other nations, notably Italy and Germany, have produced considerable numbers of aircraft, particularly flying boats, in which the power plant consisted of one or two pairs of tandem engines. The only British type with tandem engines to be used to any great extent was the Short Singapore flying boat. This is rather remarkable in view of the fact that our very first four-engined bomber, the Handley Page V/1500, had the tandem engine arrangement. Moreover, this country retained the biplane type longer than most other countries, and the tandem engine arrangement lent itself more readily to installation in a biplane than in a monoplane. What the explanation is we do not profess to know ; we can only draw attention to the fact.

Intelligence!

A GREAT many people have expressed puzzled astonishment at the system, if any, which guides the Ministry of Economic Warfare in its selection of targets for our bombers in Germany itself and German-controlled countries. In view of the predominating importance of air power, it might have been thought that aircraft factories, and the factories of the industries ancillary to them, would be obvious targets, but relatively few attempts have been made to destroy such factories; many have not had a single visit.

One cannot help wondering whether an appeal issued to the Press by the Ministry of Economic Warfare a short time ago may not throw light on the subject of target selection. The naïve appeal asked for statistical publications, official handbooks, guides, maps, plans, trade and exhibition catalogues, and street and telephone directories, *issued within the last ten years*. The italics are ours.

The inference is, and more than one publication has so interpreted the appeal, that the Ministry of Economic Warfare is singularly ill-informed concerning the loca-

tions of suitable targets. So far as the German, French and Italian aircraft industries are concerned, a wealth of information is available in directories published just before the outbreak of the war and in the possession of the Air Ministry.

The effect of such a plea upon the simple mind will presumably be to cause needless waste of man-power, congestion of postal services in sending many duplicated sources of information, the vast majority of which we vow is already in Government archives. If it is not so, then that constitutes a sad reflection upon Intelligence after 2½ years of war. Lists of synthetic oil plants, aircraft and aircraft engine factories, were placed in Government hands for checking purposes at the outset of war.

Last summer we were told that when the long winter nights were with us once more, and when we had new heavy long-range bombers capable of reaching distant targets in Germany, there would be a resumption of bombing on a large scale. The long winter nights came along, as promised, and we have been told that the production of bombers has been going forward satisfactorily, but the heavy raids do not appear to have materialised. Can it be that the Ministry of Economic Warfare was at a loss for targets until it received its ten-year-old directories, maps and guide books? "All dressed up and nowhere to go," so to speak!

A Bitter Experience

THE chief lesson taught by the daring escape of the three German warships from Brest to Heligoland is the dissipation of the theory that a fleet in harbour is just so much cold mutton for the bomb from the air.

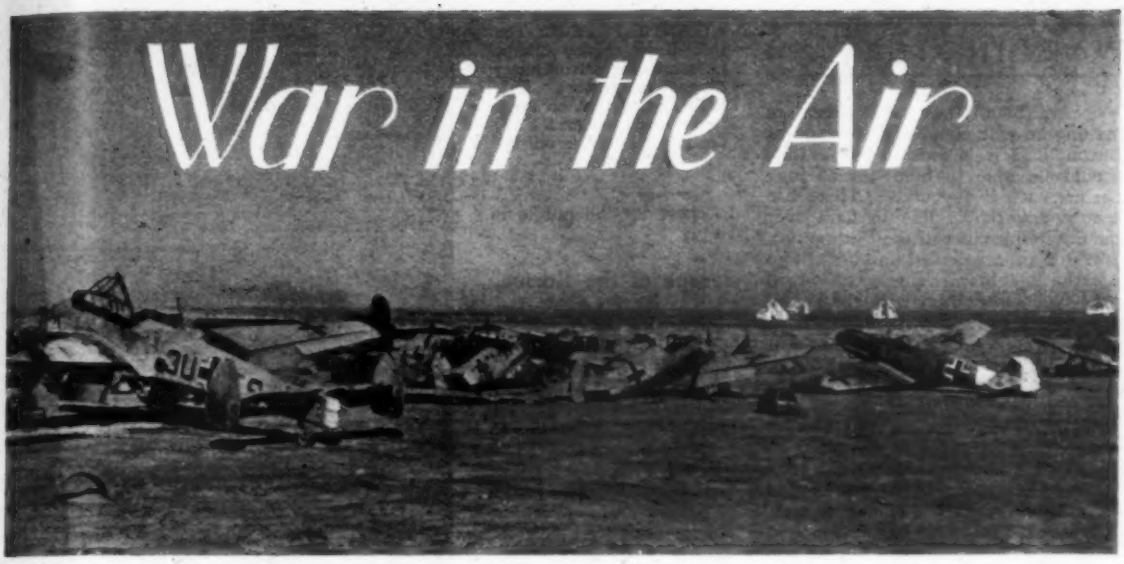
For just about a year the two larger ships have been in Brest, and the attentions of Bomber Command have kept them there, except for the *Scharnhorst's* one little excursion to La Pallice. This work of Bomber Command has been of great service in the Battle of the Atlantic. It has cost us many fine aircraft and gallant crews, but in war that sort of price has to be paid for worth-while objects. In any case, the theory, once generally held, that warships in harbour were inevitably doomed to fall victims to air attack must now be abandoned. Despite all efforts by our bombers the repairs to the German ships were carried out, at any rate up to a point where they could make a good speed through the Channel and fight hard as they steamed.

As for the fight itself, while one realises that the enemy chose his time well and was blessed with good fortune in the way of weather, one is still mystified by some points. Even allowing for very low visibility it is hard to understand why the enemy was able to steam undisturbed for from three to three and a half hours of daylight before being spotted, and then why the first reports should come, not from aircraft of Coastal Command, but from a couple of Spitfires out on patrol.

From then on, the story is one of desperate gallantry by naval aircraft, by Coastal Blenheims, by motor torpedo boats, by destroyers and by R.A.F. fighters. The men in the m.t.b.s have borne testimony to the relief which the appearance of British fighters overhead brought to them. But the whole course of the fight tells a story of desperate bravery by improvised forces hurriedly thrown in, of which only the Beauforts, with their torpedoes, were really suitable for the task in hand. In Sqn. Ldr. Cliff's squadron not one Beaufort was lost, and his pilots were convinced that they had scored at least one hit. Certainly the German ships reduced speed, and scattered.

MARCH PAST: A famous standard brought to this country from Belgium by an officer serving with the R.A.F. has been presented to a Belgian Squadron serving with Fighter Command. Taking the salute are Baron Cartier de Marchienne, Sir Archibald Sinclair, Prince Bernhardt of the Netherlands, Air Marshal Sir Sholto Douglas, M. Camille Gutt, and other Belgian Ministers. *Other pictures appear on page 161.*

War in the Air



Wrecked German aircraft, mostly Messerschmitt 109s, at Gambut.

Aircraft in Malaya : Brilliant American Air Combat : Sea and Air Fight in the Channel : Escape of the German Warships

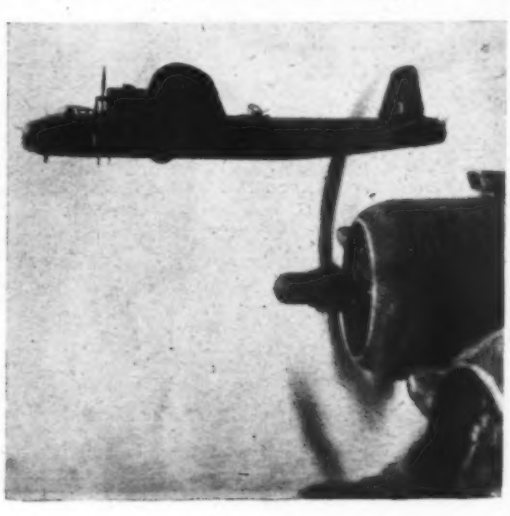
AFTER the Japanese had driven the Empire forces back into the Island of Singapore it was no surprise to hear that they had crossed the narrow strait by night and landed on the island. Then they began to send dive-bombers against our forward troops, while mortars and such heavy guns as they had been able to bring up heavily shelled our lines. Our small force of Hurricanes did its best to interfere with the Japanese bombers, but once again our shortage of fighters was severely felt.

The Need for Hurricanes

THE Prime Minister has several times explained that our rate of supplying the Middle East, and, of course, the Far East, has been mainly governed by the shipping question. But a good long time has passed since we first began sending out R.A.F. reinforcements to Malaya, and one is inclined to wonder whether we were not rather late in deciding to send Hurricanes there. Did we trust too readily to other types of fighter which were more easily transported there? At any rate, it was noticeable in the communiqués that once Hurricanes got into action the Japanese losses in aircraft began to rise. It seems that we need Hurricanes in every overseas theatre of war, while in Great Britain we need Spitfires, too. The latter type, with its narrower track, is more particular about the class of ground from which it is expected to operate.

Whether our shortage of air support was responsible to any important extent for the way in which our ground troops were steadily pushed back all through the Malayan peninsula is another question, which it is not easy to answer at such a distance from the scene of operations. We have heard much about the aptitude of the Japanese soldiers for fighting in thick jungle, climbing trees and throwing grenades down from them, infiltration, and so on, in addition to constantly turning our lines by landing fresh troops by night behind our flanks. On the face of it, aircraft could play little part in that sort of fighting. It was our loss of command of the sea, rather than any deficiency in the air, which seems to have been the turning point. Of course it was Japanese aircraft which deprived us of command of the sea by sinking our capital ships and by the treacherous attack on the American fleet, but that is past history, and what we are now considering is whether the air played a vital part or not in the land fighting. The British public is a little too ready to attribute everything to the air, and to discount the importance of the other arms. We must look forward to regaining command of the sea (and, of course, the air must play its due part in bringing about) before we can resume our rightful position in the Pacific Ocean.

In the fighting in Burma the air is certainly playing a prominent part, for there it has scope. British bombers with fighter escort made a daylight raid on Japanese positions round Martaban, on the west bank of the Salween river, and a Japanese position in northern Thailand has also been bombed. This position, Chieng Hai, is not far from the frontier of the Shan States, which are a part of Burma, and it is in the Shan hills that a force of Chinese is threatening the Japanese in Thailand. This raid was doubtless in connection with the presence of that force of our Chinese allies



ON TEST: Stirling air crews practising a little formation flying while testing their machines for the evening's work. Big aircraft are difficult to formate, especially if the wing tip is hidden by the engines.

WAR IN THE AIR

General MacArthur and his men are making an epic stand in the island of Luzon, and it is amazing that they should be able to hold out so long against such heavy odds. There has been a remarkably fine air fight over the Cavite province of the Philippines, in which an unspecified number of P40 American fighters completely wiped out six enemy fighters with the loss of only one of their own number. Incidentally, this incident has brought into prominence the name of an officer of the Philippine Air Force, a body about which not much is usually heard. The officer in question is named Capt. Jesus Villamor, and he was flying a photographic aircraft with the P40s as escort. He had just landed his machine when the enemy fighters appeared. The escort had not landed and were able to turn upon the raiders. It is to be hoped that the photographs proved useful to the defenders.

The Flying Tank Again

THE Rome wireless has broadcast the statement that the Axis forces in Libya are using tanks carried to the front by air. It is possible that some very light vehicles of not more than five tons or so might be so transported, but it could not be done on a large scale, and in the Libyan battle very light tanks are not likely to be of much use unless they appeared in considerable numbers. The light American tanks which we used in the initial encounter round Sidi Rezekh seem to have suffered fairly heavily. Any such light stuff on the Axis side would be easy prey to the 20 mm. cannons of the R.A.F. fighters. On the whole, that story need not be taken very seriously. It was probably intended to cheer up the public in Italy.

ATLANTIC PATROL: The U.S. Navy employ blimps for submarine patrols along the eastern seaboard. It is to be hoped that no long-range cannon-armed F.W. Condor will arrive on the scene.

Escape of the German Warships

ABOUT 11 a.m. on Thursday, February 12, R.A.F. aircraft reported that the German warships *Scharnhorst*, *Gneisenau* and *Prinz Eugen*, with an escort of destroyers, torpedo boats, E-boats and minesweepers, were approaching the Straits of Dover from the west. They had evidently slipped out from Brest at a moment when no Coastal Command reconnaissance machine was in the offing. A strong body of fighters flew above the ships. The movement evidently took the British authorities by surprise. The last news which we had heard of the two big German warships was that they were both in dry dock. The *Gneisenau* had been thus accommodated for months, and the *Scharnhorst* had been dry-docked after her return from her little outing to La Pallice. In the last few weeks several bombing raids on Brest by aircraft of Bomber Command had been announced, though the raids had not been so frequent or so heavy as they had been a while ago. Perhaps it had been believed that the ships needed a good deal more repair work after the long period of heavy bombing to which they had been subjected, and that there was no immediate probability of their being able to put to sea. It may also be surmised that the last thing which the Germans were expected to do was to brave the passage of the narrow Straits of Dover. If so, they scored by their daring in doing the unexpected thing. They were helped by low cloud and a visibility which varied from three to five miles, and the ships were never in sight of the English shore.

The Dover Naval Command sent out Swordfish with torpedoes and Coastal Beauforts, also carrying the same useful weapon. R.A.F. fighters swarmed overhead, and later on Bomber Command sent out its own appropriate contingent. Motor torpedo-boats likewise plunged into the fray. The enemy put up a smoke screen, and there was an intense barrage from the German ships. According to the first reports, the Swordfish scored at least one hit on one of the heavy ships, Coastal Beauforts claimed three hits, and the crews of the bombers were confident that each of the main enemy units was hit by bombs. One of the motor torpedo-boats also claimed a possible hit with a torpedo, but the smoke screen and the fury of the fire made accurate observation impossible.

At 3.45 p.m. British destroyers arrived on the scene and attacked in a rain squall. They also believed that they had scored one hit with a torpedo. However, the German ships

PILOT'S BIVVY. On the Western Desert R.A.F. air crews live in holes cut in the sand with a covering of bivouac sheets.

CAPTURED IN LIBYA

In Their Retreat Across Cyrenaica the Axis Forces Left a Variety of Aircraft Behind—Many of Them in Easily Repairable Condition

One of the latest type Messerschmitt Me 109F fighters which was shot down and later salvaged by the Royal Air Force mechanics.

A Fiat G50 fighter which—despite the cunning of the fox on the fin—fell into our hands. The two synchronised machine guns can be seen where the fairing is open in front of the pilot's cockpit.

With its 870 h.p. B.M.W. 132 Dc engine drooping somewhat, this Henschel H.S.126 was deserted on the airfield at Tmimi.

(Above) Aerial lorry, trooper, paratrooper and glider—towing machine, the Junkers Ju 52, has been used in thousands by the *Luftwaffe*. This particular one feels it is a very one-sided war.

(Right) A Junkers Ju 88 is considered to be a useful prize. This one was captured while still wearing fabric covers over the wheels to protect the synthetic rubber from the African sun.

WAR IN THE AIR

ENEMY AIR LOSSES TO FEB. 14th.

	Over G.B.	Over Continent	Middle East	Far East
Feb. 8	0	1	4	7
" 9	0	0	3	18
" 10	0	0	0	0
" 11	0	0	2	5
" 12	1	18	7	2
" 13	0	1	5	4
" 14	0	0	21	0
	1	20	42	36

Totals: North, 5,644; Middle East, over 3,499; Far East, 227.

scattered and escaped from the eastern end of the Channel, and when last seen that afternoon were making for their ports in the Heligoland Bight.

Fifteen German fighters were shot down by our fighter escort and at least three more by our bombers. We lost 16 fighters, six Swordfish, five machines of Coastal Command, and 15 of Bomber Command—a total of 42 machines.

In a fight like this in the Channel, when the British authorities were evidently caught unprepared and had to throw in all available resources, regardless of whether they were the ideal best, grievous losses were to be expected. The first striking force was a formation of six Swordfish, led by Lt. Cdr. E. Esmonde, D.S.O., who had only a few days before been decorated by the King for the part which he played in leading his squadron off the flight deck of H.M.S. *Victorious* to attack the *Bismarck*. That time his Swordfish reduced the enemy's speed and so led to the destruction of the great battleship. This time conditions were very different, and not one of the six Swordfish came back. Five men from their crews were picked up, some wounded, but their gallant leader was not among the survivors.

A squadron of Coastal Beauforts, led by Sqn. Ldr. W. H. Cliff, had better fortune. They claimed three hits, and did not lose a single aircraft. Bomb-carrying Hurricanes took part in the attack, though their missiles would not have much effect on the big ships, and they probably only attacked the escort vessels.

An officer who led the motor torpedo boats gave a broadcast account of the share in the fight taken by his flotilla, and bore testimony to the relief which the boats experienced when British fighters appeared overhead and distracted the attention of the German fighters from the sea craft. During the action, between 200 and 300 British fighters went up, while the air striking force consisted of between 200 and 300 bombers, including torpedo aircraft. Not one of our motor torpedo boats or destroyers was lost, though naturally damage was suffered.

It seems certain that the three big German ships were damaged, for all reduced speed, and when they reached the open North Sea they scattered to present less concentrated targets, but they all made good their escape. Some of the torpedo hits were probably made by the heavy weapons of the surface craft, which do far more damage than the air torpedoes.

BURMESE HIGHWAYMEN: Refuelling a Tomahawk of the American Volunteer Group who are fighting on behalf of the Chinese in defence of the Burma Road supply line. The machines carry the international marking of China.

The Fall of Singapore

FOR some time past the feeling has been general that Singapore must fall, and one cannot help a feeling of relief that the unfortunate inhabitants have been relieved from the inferno of bombing and shelling to which they have recently been subjected. The squadrons of the R.A.F. and R.A.A.F. were evidently withdrawn from the island some time ago, and have been operating from bases in the Netherlands East Indies. Anxiety must now be felt for those Dutch islands, and the "scorched earth" policy which has been pursued will deprive the forces of the united nations of their chief oil supplies. But Japan's success can only be temporary. She cannot hold out indefinitely against British and American power.

BUMPED OFF—Nearly: The bomb bay of a low-flying Hudson which hit the water while on patrol along the Atlantic coast of France. The wireless operator sent out an S O S, but the pilot managed to nurse the aircraft back to base.

BRITISH AIR LOSSES TO FEB. 14th.

	Over G.B. A'crft.	Over Continent B'brs.	Over Continent Ftrs.	Middle East A'crft.	Far East A'crft.
Feb. 8	0	2	0	6	0
" 9	0	0	0	0	0
" 10	0	1	0	0	0
" 11	0	2	1	6	2
" 12	0	26	16	4	0
" 13	0	0	2	6	3
" 14	0	2	0	1	0
	0	33	19	23	5

Totals: North, 3,260; Middle East about 956; Far East, 26.

MORE ABOUT JET PROPULSION

Features of the Caproni Campini : A New Heinkel Scheme

By G. GEOFFREY SMITH, M.B.E.

SCEPTICS have tended to dismiss the subject of jet propulsion of aircraft as a dream of the future. The present notes regarding the first successful public demonstration of an Italian jet-propelled machine should dispel any ideas that jet propulsion is merely an armchair flight of imagination. The first description of a proposed Heinkel plant reveals the interest of another Axis partner in this method of propulsion.

WORLD-WIDE publicity has been accorded to the public demonstration flights of an Italian jet-propelled aircraft already referred to in *Flight*. Italian propaganda has naturally made the most of the success, with the result that the radio and the Press of many countries have given prominence to the Rome-Milan flight. Nevertheless, little has been disclosed regarding the propulsive system or the construction of the craft.

Italy is very busy experimenting with future types. Signor Gaspare Santagelo said as much in discussing development and production of aircraft in Italy, and emphasised that their practical value would become evident in the near future if research was maintained. He then especially mentioned the Caproni-Campini jet-propelled aircraft. Briefly describing the machine, he stated that a nozzle duct runs along the entire length of the fuselage. In the forward portion of this duct an axial compressor driven by an engine produces a pressure increase which creates an airflow towards the aft portion of the duct. This air stream first absorbs heat in cooling the engine and is then joined by the engine exhaust gases which further increase its thermal value. The expansion towards the exit is intensified by the addition of liquid fuel which is injected and ignited in the vicinity of the discharge nozzle. It will be noted that the usual heat losses involved in cooling the engine and in discharging the exhaust gases to atmosphere are in this system avoided.

Rearward thrust is, therefore, created by the blower, on the one hand, and by the expansion of the air and gases situated behind, on the other. The force exerted by the stream, or jet, is the product of its mass and velocity. Fundamentally, a force acting in a given direction exerts an equal and opposite force. It is this reaction which propels the aircraft.

This method of propulsion reveals its advantages, particularly at speeds approaching the velocity of sound, he added, but he gave no suggestion that such speeds had been accomplished on the machine under consideration. The intake duct in the nose of the machine would appear to be of divergent section to build up pressure in the air stream at the expense of velocity. As a result, the velocity of the air at the blower intake would be lower than the flying speed, and thus the impeller blades can operate at a higher degree of efficiency than the airscrew blades of conventional aircraft power plants.

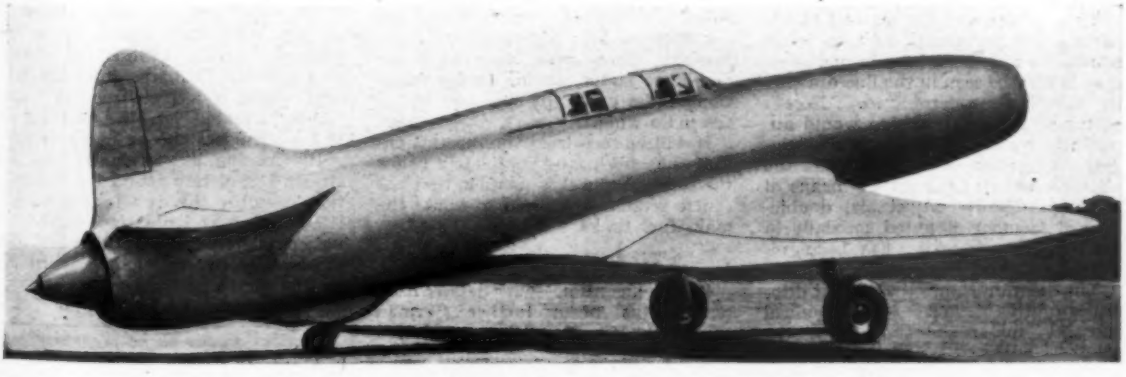
A Radial Engine Used

From another foreign source it was learned that the engine employed in the Caproni-Campini was of Isotta Fraschini manufacture. Merely as a hazard it may be suggested that the unit referred to may be of the "Astro 7c40" type, a seven-cylinder, air-cooled, supercharged radial having overall dimensions of 47in. diameter and 44in. length. Normally, its rated output is 440 h.p. at 2,000 r.p.m. at an altitude of 4,000 m. (13,120ft.). Possibly its performance has been improved, as in the jet propelled machine it draws its air supply from the stream leaving the main blower, which is at some pressure above that of the surrounding air.

It will be recalled that an earlier Campini design, a drawing of which was given in *Flight* of August 28th, 1941, also employed a radial engine to drive the compressor. In that instance, however, the engine was located before the compressor. One school of designers, particularly Italian and Swiss, holds the opinion that a reciprocating engine should furnish motive power for the compressor in order that advantage may be taken of a relatively high compression ratio for the more efficient combustion of the fuel and also for the convenience of using a known and fully developed type of power unit. There is a considerable degree of justification for this viewpoint; but, as the series of *Flight* articles last year showed, the trend in other countries would seem to be towards a gas turbine located after the combustion chamber or chambers.

High Speed Not Attempted

A Spanish aviation journal gives a review of the Campini machine which was flown from Milan to Guidonia, Rome, on Sunday, November 30th, 1941. It was piloted by Col. Mario de Bernardi, the veteran Schneider Trophy ace, and a Capt. Pedace was the second occupant. On arrival at Guidonia the designer explained that high speed had not been attempted on this first public flight. Actually 2¼ hours were taken for the journey, but this included a stop of unspecified duration at Pisa. The average speed was about 130 m.p.h. No reason was given for the break in the journey, but the critical suggestion has been advanced that the stop was necessary for refuelling. It is rumoured that the rate of fuel consumption is, at present, relatively high. The machine is now, it is understood, being subjected to



This side elevation gives a good impression of the large diameter, rocket-shaped fuselage which functions as the main air duct.

MORE ABOUT JET PROPULSION

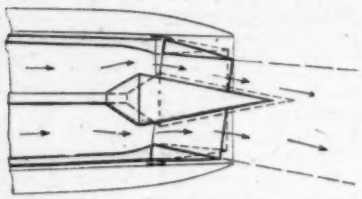


Diagram showing the method of regulating the propulsive jet and the possible arrangement for swivelling the discharge nozzle to assist manœuvring.

tests at the Guidonia Research Laboratory.

Doubtless the flight had been well publicised in advance, but as the experimental Caproni monoplane passed over cities en route, interest was particularly aroused by the unusual character of the noise created by the machine. This would be largely explained by the absence of the usual airscrew whirr.

When, as *Flight* has already recorded, the Campini machine was first flown in 1940 at the Forlanini airdrome and remained in the air ten minutes, Italian engineers were jubilant at the demonstration of their technical success. This was understandable in view of the experiments known to be proceeding in several countries. It was at once proclaimed to the world that this successful flight was the prelude to a revolution in the design of power units and aircraft.

Differences in Layout

From a close examination of new views of the Caproni-Campini aircraft, the first illustration of which appeared in *Flight* of December 4th, 1941, it is clear that the only opening for the admission of air is a circular duct in the nose, and the only discharge nozzle is in the tail of the fuselage. Thus the scheme departs materially from the original layout which had a pressure cabin in the nose and admitted air *via* a peripheral duct at the point of maximum pressure on the fuselage.

This feature and the method of adjusting the peripheral duct to meet conditions at sub-sonic and super-sonic speeds may be seen in the line drawing in the issue referred to. Recent pictures of the new design would apparently confirm that Campini's original suggestion of controlling the characteristics of the jet by means of a longitudinally adjustable, double-conical member mounted coaxially in the discharge nozzle, has been retained.

The diagram shows the general principles of this device. As the conical member, under the control of the pilot, is adjusted axially, the cross-sectional area of the nozzle aperture is varied in much the same manner as a tapered needle may be employed to alter the effective area of a carburettor jet. Although there is no specific information available on this point, it would also seem possible by means of this device to adjust the discharge nozzle to either a convergent or a divergent contour. If this is actually so it would become possible in some degree to regulate the terminal pressure of the jet and also the terminal velocity. The point of the conical member will be seen actually projecting beyond the discharge orifice in the side elevation of the machine.

The original design proposed the use of a universally swivelling discharge nozzle in order to impart direction to the jet, as also shown in the diagram. Externally there is no evidence of this being employed on the latest design, which is provided with the conventional elevators and rudder. However, within the not inconsiderable girth of the tail end of the fuselage it is conceivable that the swivelling mechanism is completely enclosed by the external skin. At present-day speeds in flight it is doubtful if facility to give direction to the jet is a feature of importance, but probably it would be of assistance in manœuvring the machine on the ground. It must be remembered that there is no airscrew slipstream for the rudder on a jet-propelled machine of this type.

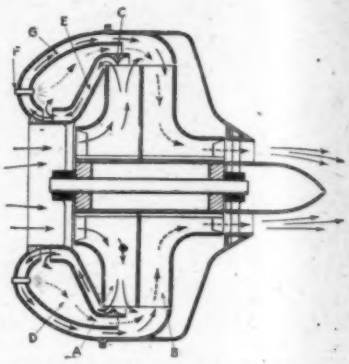
In referring to the girth of the fuselage it would seem that the cross-sectional dimension would be at least 6ft. diameter, as the engine, which is presumed to be a radial type, is approximately 4ft. in diameter. In general, the fuselage is of rocket shape and the structure, and also that of the wings and tail planes, is of duralumin. Wing roots appear to be unusually generously proportioned. This may be accounted for by the need for all structural attachments to be arranged externally in order to leave the interior of the fuselage unobstructed for the main air duct.

The same reasoning may provide an explanation for the peculiar bulge below the fuselage from which the tail wheel is supported. Furthermore, this necessity to keep the interior of the fuselage clear may have been the dominant factor leading to the adoption of the unusually low position of the main wing.

It will be seen from the illustrations that the wing passes completely below the fuselage and it is possible that the centre section is utilised to house the main fuel tanks.

A New German Design

In the meantime some details have reached us of a further German scheme of jet propulsion, sponsored this time by none other than the firm of Ernst Heinkel. The designer Herr Max Hahn, of Seestadt Postock, has



A self-contained, all-rotary jet propulsion unit recently patented by the German firm of Ernst Heinkel.

evolved what appears to be a simple and compact unit embodying a turbine and compressor in combination. The main feature of the design will be appreciated from the diagram.

In a circular casing having an axial air intake at the front and coaxial discharge orifice at the rear, a shaft is mounted in two bearings supported on spiders. On this shaft is a single rotor which is divided to form a box-type blower impeller A and a boxed turbine wheel B. Air drawn into the unit through the forward central aperture leaves the impeller at its periphery and the stream is here divided by a projecting guide C on the enshrouding wall of the annular combustion chamber D.

The main supply is diverted to the rear to the turbine wheel, whilst a smaller portion passes along passage E between the main casing and the combustion chamber wall. At the point of smallest diameter, surrounding the intake aperture, this portion of the airstream is again divided. Part enters chamber D into which fuel is injected by nozzles F and burnt to furnish additional heat for the final jet. The remainder continues around the combustion chamber in space G and joins the initial airstream and the effluent from the combustion chamber to form a common stream which expands through the turbine and furnishes the motive power for rotating the blower. The annular discharge from the turbine wheel is a high velocity, rearwardly directed jet, the reaction of which furnishes the propulsive effort.

By passing a portion of the airstream completely round the combustion chamber this is effectively insulated and heat from the chamber is not completely lost by radiation to the atmosphere but is largely carried off by the air to perform useful work in expansion through the turbine.

Previous articles on jet propulsion have appeared in issues of "Flight" dated Aug. 28th, Sept. 11th, Sept. 25th, Oct. 9th and Dec. 4th, 1941.

THE IMPORTANCE of MALTA

The Geo-strategic Situation : Malta Britain's Advanced Air Base : The Effect of Operations from Malta on the Italians : Malta's Defiance

By V. L. G.

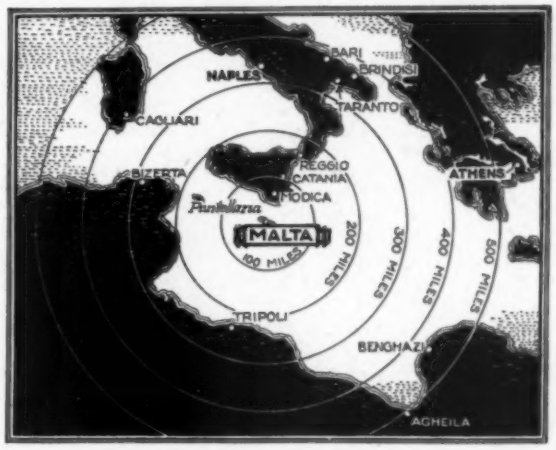
NEWS from the Libyan front appears to confirm the suggestion put forward in *Flight* of January 29th, that the Germans may intensify their drive in N. Africa. The forces they have thrown into the battle and their equipment suggest that they will spare no endeavour in their attempt to regain the control of the North African seaboard.

In connection with these operations the island of Malta deserves special attention. Before this war, the opinion was frequently voiced that the advance of the air arm had considerably reduced the military value of this island.

But the reality has proved to be different. More than 1,000 times have enemy air forces raided Malta. The intensity of these raids has varied in accordance with their immediate tactical value. But despite the punishment received, Malta has retained, and indeed strengthened, her important position in the Mediterranean system of air strategy.

It is important to realise that the offensive value of an air base cannot be adequately expressed in terms of proximity or distance to enemy objectives. It is the relative importance to the enemy war effort of such objectives as are situated within operational range from an air base that forms the criterion of the offensive value of an air base.

From this point of view, the geographical position of Malta places the island among the most important of British air bases. The distance from Malta to vital population and production centres of Italy is two-thirds of that of any other British base. This advance position appears even more striking if compared with the Axis air bases in the Western Mediterranean.



British air forces based on Malta can hurl their machines and throw their bomb loads (manufactured many miles away from the Italian bases) against the very nerve centres of the Italian production and supply system. Axis aviation based on Sicily, while capable of inflicting punishment on Allied military movements and convoys, cannot reduce the production capacity of the Allies.

Moreover, situated in a focal point amidst vital Italian routes from Messina to Tripoli and the great longitudinal seaway from the Western to the Central Mediterranean, Malta creates danger zones and obstacles for the shipping communications of the Axis.

In the present struggle for the possession of the Southern Mediterranean seaboard, Malta is assigned the important task of interfering and cutting Axis supply lines from Italy to the Nazi forces in Libya.

Were it not for the hitting capacity of Malta, the Axis would be able to maintain an uninterrupted flow of men and material from supply centres on the continent to the combat area in Africa. As it is, however, R.A.F. aircraft using Malta as a final springboard have alone, during the month of November, dropped over one million bombs on enemy objectives and flown 250,000 miles on these operations.

It would, of course, be absurd to expect an air-base, no matter how strong, to be capable of preventing all airborne surface supplies from Sicily to Tripoli. The domination of the air space cannot be made so monopolistic as to ensure the complete disappearance of enemy aircraft in this sector. Some infiltration must be possible. Under cover of night and bad weather, enemy air transports can undoubtedly manage to escape the attention of the R.A.F. Resourceful as the enemy is, he uses surface vessels, aircraft supply carriers and towed gliders in this attempt to keep his supply lines to Libya in working order. But supplied and adequately equipped, Malta remains the major stumbling block for the consolidation of the Axis forces in North Africa.

This offensive capacity is particularly important when supporting operations against an enemy whose nearest hinterland reserves are beyond Malta and within striking range of aircraft based there. For the offensive radii expanding from Malta can substantially help to reduce the striking power of the enemy in this theatre of war.

The dangers to which enemy supplies are exposed in the region of Malta are best shown by the following comment in a recent Italian periodical: "A convoy directed from Tripoli cannot always follow a route outside the radius of 200 miles from the British base. Hence the ability of the enemy to learn about and follow the movements of Axis transports and to launch an attack against them. The enemy has an enormous advantage because the initiative is in his hands and a close base at his disposal. If to that we add the operations of short range bombers and torpedo aircraft, we can realise the full value of Malta as an advanced air base."

But apart from their military value, the psychological effect of these operations radiating from Malta deserves special mention.

To replace the idea of "Mare Nostrum," which for good reasons seems to be losing ground with the Italians, an "Ersatz" slogan is being offered to the masses. The revised parole is "Navigare Necesse Est," and expresses the resigned attitude to consider seafaring under present conditions in the Mediterranean a necessary evil. To appreciate this new attitude it is best to quote again a recent Italian comment on Malta:—

"Italy is like a man who has to cross a path on a more or less urgent errand, but who suspects that at any time he may be attacked without knowing by how many enemies and from which direction. He thinks of it and imagines that the assailants understand the advantage of sighting without being seen, of attacking and disappearing. He thinks of all this and imagines that other men, ready to lend a hand in the assault, would jump upon him and then hastily vanish in the darkness."

If this is a portrait of the psychological condition of the Axis naval forces, Malta's contribution to the war effort should indeed be even more appreciated.

Needless to say, the position of Malta would be greatly reinforced in the event of the collapse of the Axis resistance in North Africa. For Malta would then be linked up by ground communications to Egypt and to the important Eastern block of Allied bases. While continuing to function as a spearhead of British air offensive against the Italian mainland, Malta could even more effectively help to ensure the security of an increased Allied trans-Mediterranean traffic.

Twenty-sixth of the Second Series

FRIEND or FOE?

Two Twin-tailed British Bombers : Whitley and Manchester

WHITLEY : Twin fins and rudders above rectangular tailplane, set well inboard from tips, and strut-braced to fuselage ; slight straight taper to all leading-edges. Stinger gun-turret ; fixed tail wheel.

HERE are two well-known British heavy bombers which, though they fall into the same category in all essentials so far as visible externals are concerned, nevertheless have certain distinctive differences which will enable the learner-spotter to differentiate between them. Generally speaking, of course, the chief thing the spotter wants to know is whether the aircraft he sees approaching be "ours or theirs," but one can readily imagine special circumstances when it may be necessary for him to make a positive identification. The Armstrong Whitworth Whitley and the Avro Manchester are a pair which provide good exercise in this respect.

Two outstanding structural differences will at once be noticed from a glance at the accompanying illustrations. The Whitley has its twin fins and rudders set inboard from the tailplane tips whereas those of the Manchester are outrigged on the tips, and the latter, alone, possesses a dorsal gun turret. Both, it will be noted, have "stinger" turrets in the tails of their fuselages.

We are concerned, here, chiefly with the tail assemblies (the general characteristics of the Whitley having been dealt with in the first series of "Friend or Foe?" before details of the Manchester were released for publication), but it will be as well to mention briefly that, whereas the Whitley has a particularly long, rectangular fuselage and appears to fly in a nose-down attitude, the Manchester fuselage boasts quite a nice line, is deeper in section compared with its length, and has a gently curving underside. Incidentally, both have non-retracting tail wheels.

To compare their tail surfaces in detail, the Whitley conforms in this respect to the machine's general angularity. The fins and rudders, which are strut-braced to the fuselage, sit atop the tailplane, have a straight slope to the leading-edges, flat apexes and vertical trailing-edges, but with the heels of the rudders slightly rounded off. Mass balances project from the tops of the rudders, the corners of which are also very slightly rounded.

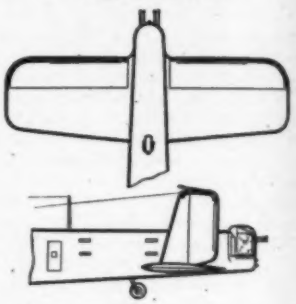
The tailplane, of moderate aspect-ratio, is practically a rectangle except that the corners of the broad tips are again slightly rounded ; this is rather more noticeable on the elevators than at the extremity of the leading-edge which has an almost imperceptible straight taper.

The vertical tail surfaces of the Manchester are in distinct contrast. Of high aspect-ratio, they resemble elongated eggs, the greater portion of which project above the level of the tailplane ; they are of cantilever construction and have no external strut-bracing.

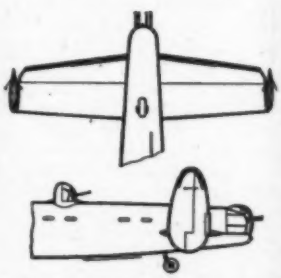
The tailplane is also of higher aspect-ratio than that of the Whitley, and has a straight leading-edge and a tapered trailing-edge, the elevators being cut away at an angle at the tips.

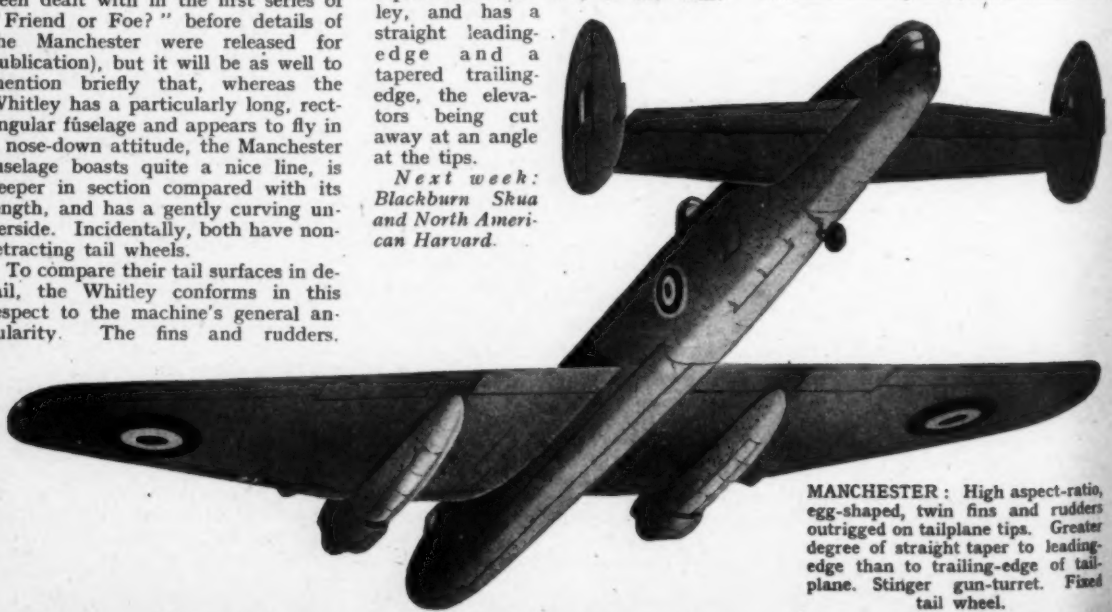
Next week: Blackburn Skua and North American Harvard.

WHITLEY V



MANCHESTER





MANCHESTER : High aspect-ratio, egg-shaped, twin fins and rudders outrigged on tailplane tips. Greater degree of straight taper to leading-edge than to trailing-edge of tailplane. Stinger gun-turret. Fixed tail wheel.

England's "Fours"

First British four-engined bomber, the Handley Page V/1500, appeared in May, 1918. It cruised at 75 m.p.h. and carried a military load of 6,500 lbs.

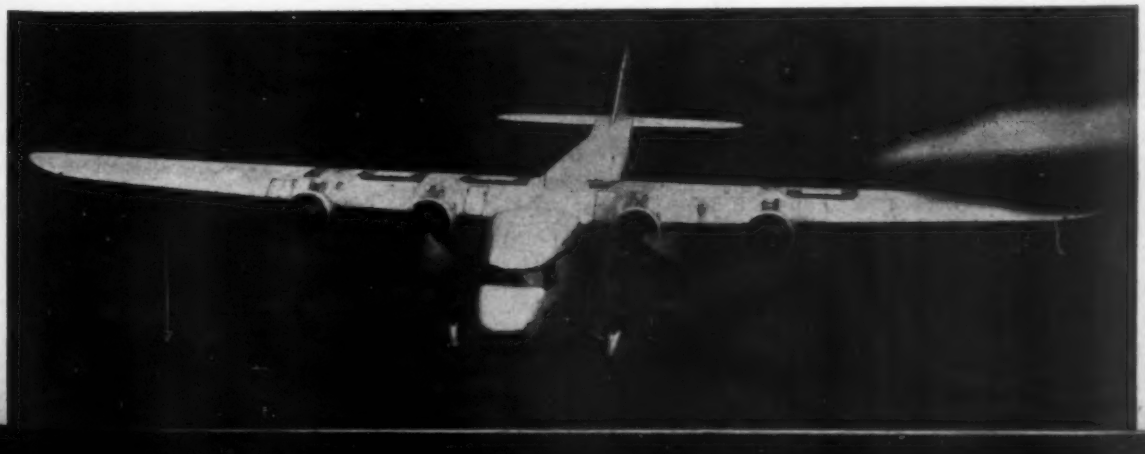
Twenty-four Years' Experience in the Design, Construction and Operation of Four-engined Aircraft : Military Load Increased from 6,000 lb. to 18,000 lb. : Range from 600 to 2,000 Miles

FOR certain military operations, that bomber is the most effective which will carry the greatest bomb load over the longest distance at the highest speed. One might, in fact, employ as a figure of effectiveness a simple formula in which these three factors were multiplied together. Applied to modern high-speed, long-range bombers carrying a heavy bomb load, the actual figure thus derived would, however, be somewhat cumbersome. The late Anthony Fokker used a formula somewhat of this nature to denote the efficiency of commercial aircraft, and in order to introduce the efficiency factor (as distinct from effectiveness factor) he divided the product by the horse-power figure. Mathematicians may argue about how the different items should be treated ; some will say that they should be multiplied together, others that they should be added, or that some of them should be added and the sum multiplied and divided by the remainder. That does not concern us here, since we are only interested in the best way to carry the bomb or other load as far and as fast as possible.

Closely connected with this problem is the total horse-power available, the results of which are reflected in speed and load-carrying capacity. Early aircraft were of the single-engined type. Then, as it became desirable to lift greater loads, two engines were used, and as the combined power of two engines was insufficient for the ever-increasing loads, three and four engines were fitted. It is obvious that no designer would use four engines if he could get two to do the required work, especially nowadays when aircraft engines have become so amazingly reliable. It was rather different in the early days of flying. Engines

The Armstrong Whitworth Atalanta (A.W.XV) was the first British four-engined cantilever monoplane. It was produced in 1931 and, with four 340 h.p. Serval engines and a loaded weight of 21,000 lb., had a top speed of 156 m.p.h.

"Flight" photograph.



ENGLAND'S "FOURS"

then gave all manner of trouble, and there was something to be said for using four in order to have three-quarters of the total power left when one unit failed, instead of only one-half in the case of a twin-engined type. Four engines mean much greater complication, greater installation weight, and probably greater drag. The latter is, perhaps, open to debate, since it is conceivable that four fairly small engines, neatly faired into the wing, might actually offer less drag than two large engines protruding from the wing contour. It is largely a case of relative size.

The point it is desired to make is that when an aircraft designer fits four engines he usually does so because no two units of available engines would give the necessary power. It has been so from the earliest days, and seems likely to be so in the future, for as engine size and power increase, so does the size of the aircraft designed for the larger units; and it is a fairly safe assumption that no sooner is a new and more powerful engine produced than the aircraft designer gets to work to design a large aircraft around it.

Since it appears likely that four-engined aircraft will always be with us, and in view of the fact that this country's part in developing the four-engined class is sometimes apt to be overlooked when the modern bomber of this type is mentioned, we have thought it of interest to trace briefly the work done by British designers during a period of nearly a quarter of a century. Many of the types included cannot be said to be, in themselves, links in the evolutionary chain, but every one has contributed something to the knowledge of the designer and the experience of the operator, even when it was a purely civil type with no obvious bearing on bomber design problems.

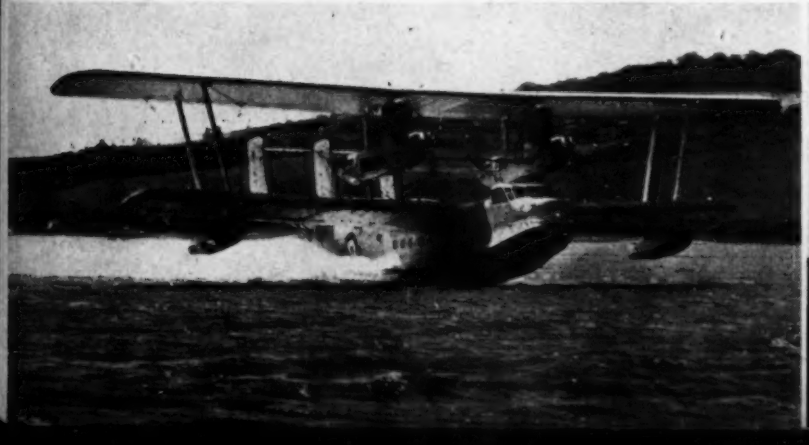
A beginning was made when, one day in May of 1918, a huge Handley Page biplane with four Rolls-Royce Eagle engines of about 360 h.p. each made its first test flight. Known as the V/1500, this machine was a development

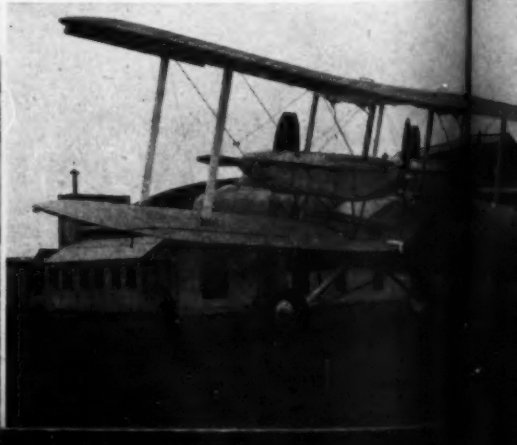
In 1930 the Handley Page firm produced the H.P.42 type, the first of which [illegible] named seizing and the pieces of the fractured airscrew hitting and smashing the [illegible] three carrying 95,000 passengers over one and a quar[illegible]illion

In the Short Kent class (above) the four Bristol 550 h.p. Jupiter engines were mounted in line abreast, an arrangement which afforded an interesting comparison with that of the H.P. 42 produced in the same year.

Last British reversion to the tandem engine arrangement was the Short Singapore III, which preceded the Kent class. It had four Rolls-Royce Kestrel engines of 560 h.p. each and a maximum speed of 145 m.p.h. The clean running on the water is well shown in the picture below.

"Flight" photographs.





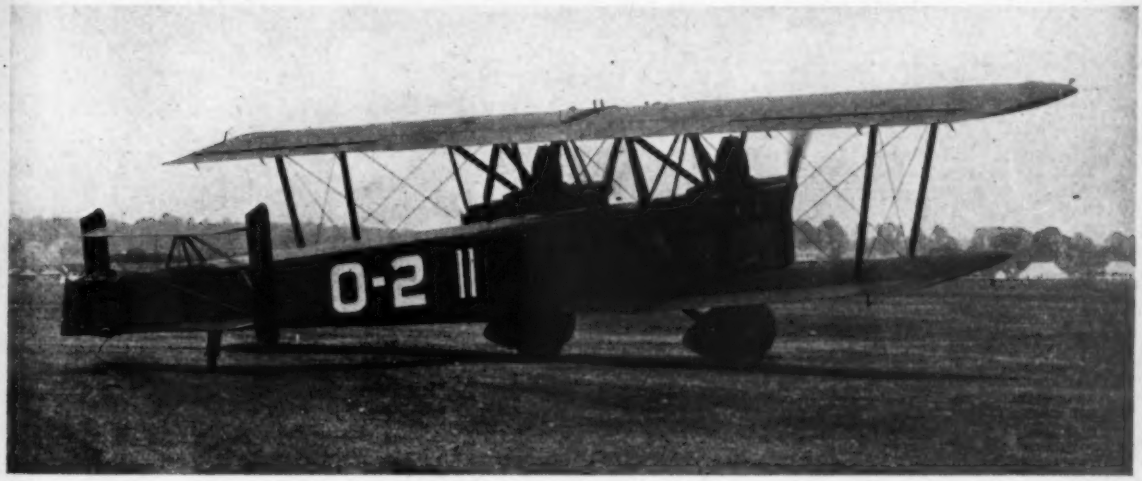
"Flight" photograph.

irst of which was named *Hannibal*. It came to grief quite early in its career, one engine mashing the ... three. Later examples of the type gave excellent service, one of them ... and a quarter million miles without injury to a single passenger.

m.p.h. cruising), but the range was just about sufficient to reach Berlin from the nearest point in France, and the military load was in the neighbourhood of 6,000 lb., which was considered very remarkable in those days. Only three of the V/1500s were ready when the Armistice came in November, 1918, and so Berlin escaped its just deserts that time. The machine would carry a 3,300-lb. bomb.

When commercial aviation came into being after the war 1914-18 a beginning was made with small aircraft, but as the demand for air travel grew the need for larger aircraft made itself felt, and by 1930 the earlier twin-engined Handley Pages had to be supplemented with a number of four-engined machines. These were of the H.P.42 type, the first being named *Hannibal*. Instead of the tandem engine arrangement of the V/1500 a somewhat unusual placing of the engines was adopted. Two of the engines were mounted on the lower wing, and two under the upper. There were certain misgivings about this arrangement, as the distance of the thrust lines of the top engines to the centre of gravity was considerable. However, the machine proved a success, after a few initial setbacks, and one of the class distinguished itself by flying one and a quarter million miles, and carrying 95,000 passengers without injury to one of them. The engines were Bristol Jupiter air-cooled radials of 550 h.p.

A third variation of the four-engine arrangement was the mounting, in line abreast, of the power units. The

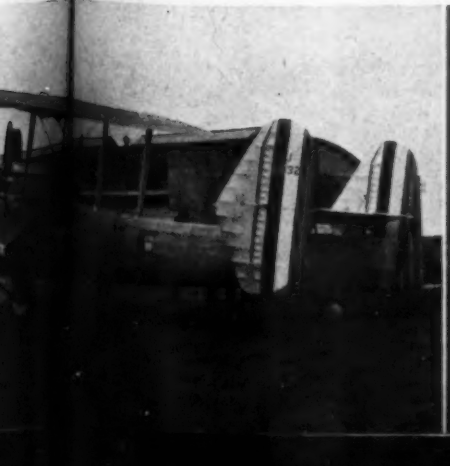


of the earlier twin-engined O/400. The Eagle was the most powerful aircraft engine available at that time, and as two were not sufficient to carry the bomb load and fuel needed to reach Berlin, the Handley Page designers were obliged to resort to a four-engined arrangement. As the picture at the top of page *c* shows, the V/1500 was an equal-span biplane, with the engines mounted in tandem pairs in the gap between the wings. There was little attempt at streamlining, the engines not even being cowled (the argument being that the extra cooling was of greater value than any saving in drag), and the biplane tail and four-wheeled undercarriage all added to the "built-in headwind." It is thus hardly surprising that the speed was low (about 75

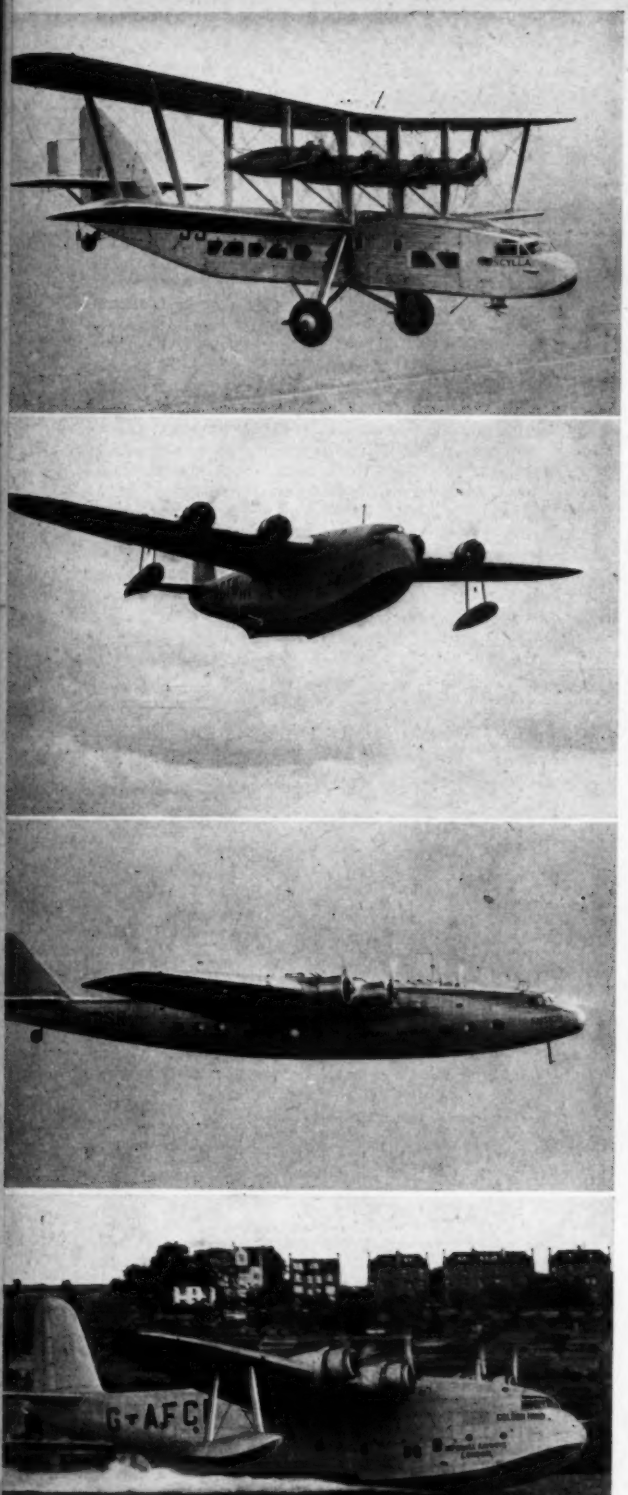
In 1931 two experimental troop-carriers were built, the Vickers 163 (above), and the Gloster (in the centre, below). Both had four Rolls-Royce Kestrel engines. The Gloster machine was the cleaner of the two and a good deal faster than the Vickers. When the types had been thoroughly tested, the Air Ministry decided the class was not wanted, and no more were built.

Refinement in biplanes. In 1934 the De Havilland company produced the D.H. 86, with four Gipsy-Six engines of 200 h.p. each. Notable features were the high-aspect ratio biplane wings, the small number of struts, and the "trousered" undercarriage. The picture below shows a later version, the D.H.86A.

"Flight" photographs.



ENGLAND'S "FOURS"



"*Flight*" photographs.

Four four-engined types. Reading from top to bottom they are: The Short Scylla, which had the superstructure of the Kent class boats mounted on a landplane fuselage; the Short Empire boat (740 h.p. Pegasus), the Armstrong-Whitworth Ensign (Siddeley 800 h.p. Tiger), and the Short G-class boat (1,300 h.p. Bristol Hercules). The contrast between the Scylla and the other types is most striking and indicates why the change-over to monoplanes resulted in such a vast improvement in performance.

first type to appear with this arrangement was the Short flying boat *Kent*. This might be said to be an enlarged development of the Short *Calcutta*, which had three engines abreast in the gap between the wings. The four-engined boat had Bristol Jupiters of the same type as those fitted in the H.P.42, and thus a comparison was rather interesting. Both types had a loaded weight in the neighbourhood of 30,000 lb., and both cruised at around the 100 m.p.h. mark, while the maximum speed was about 130 m.p.h. There does not, therefore, appear to have been much to choose between the two engine arrangements. A landplane version, known as the Scylla, was also introduced.

Tandem Engines

Before producing the Kent class, Short Brothers had designed and built a military four-engined boat, the Singapore III, in which the Rolls-Royce water-cooled Kestrel engines, of 560 h.p. each, were mounted in tandem pairs on the inter-plane struts. The loaded weight was somewhat lower than that of the four-engined Kent class (27,500 lb.), but the difference is hardly sufficient to account for the much higher maximum speed of 145 m.p.h., so that one must assume that the tandem arrangement of water-cooled engines had lower drag than the line-abreast aircooled. In spite of this fact, the Short Singapore was the last British four-engined aircraft to go into service with tandem engines.

So far we have dealt with four-engined biplanes only. In 1931 there appeared a four-engined monoplane which may be said to have been the forerunner of the modern formula in that it had a cantilever monoplane wing, with the engines on the leading-edge. The undercarriage was not retractable, but was carefully faired. The machine, the Armstrong-Whitworth *Atalanta*, or A.W. XV, was a commercial machine of 21,000 lb. gross weight. With four Armstrong Siddeley Serval engines of 340 h.p. each it had a maximum speed of 156 m.p.h., which must be regarded as a great improvement on the types dealt with above, especially in view of the modest horse-power. The machine saw much service on the African sections of the Empire air routes and did well, although obviously it would have been improved by having more powerful engines.

Mention has been made above of the fact that the Singapore III was the last four-engined type to go into service. Other machines were, however, built experimentally, of which we may mention the Vickers 163, which appeared in 1931, and the Gloster troop-carrier, which was seen in public at the R.A.F. Display of 1932. Both were biplanes, and both had four Rolls-Royce Kestrel engines. The Air Ministry decided the type was not wanted, and no more were built.

Biplane Refinement

Turning again from military to commercial aircraft, by 1934 we find beginnings of careful streamlining of four-engined biplanes. In that year appeared the first De Havilland machine of this class, the D.H.86. The biplane wings, of equal span, were highly tapered in chord, and the number of interplane struts was reduced to a minimum. Wheel retraction was rather out of the question in a biplane, but the undercarriage was well "trousered." With a gross weight of 9,200 lb. and powered by four 200 h.p. Gipsy-Six engines, the original machine had a top speed of 170 m.p.h. Later versions were fitted with controllable-pitch airscrews, the loaded weight increased to 11,000 lb., and the operational speed, as distinct from the all-out maximum speed, was as high as 160 m.p.h. It would appear that "cleaning up" paid very well!

The D.H.86 family may be said to have marked the end of the four-engined biplane, and although the class continued for many years to give good service, no biplane successor was designed. The twin-engined Comet designed for the England-Australia race, which it won, gave the designers valuable data for a very much larger four-engined development, but this came some time later in the chronological sequence.

In the meantime Imperial Airways had placed an order

ENGLAND'S "FOURS"

"Flight" photograph.

Cleanest of all our four-engined types was the De Havilland Albatross (four 525 h.p. D.H. Gipsy-Twelve engines). The machine was a commercial type and may be said to be inspired by the Comet which won the England-Australia race. Its cruising speed was about 200 m.p.h. The first test flight was made in May, 1937.

with Short Brothers for a large number of monoplane flying boats. The order was placed without the preliminary of building and testing a prototype, and it speaks volumes for Mr. Arthur Gouge and his staff that when the first of these boats was tested no major modification was needed. This was partly due to the long experience of the Short firm, and partly to the building of a small four-engined floatplane which was virtually a flying scale model of the large boat. Known as the Scion Senior, this machine was a development of a smaller twin-engined type, the Scion. With four 90 h.p. Pobjoy Niagara radial engines, the Scion Senior appeared first in 1935 as a twin-float seaplane, but it was designed also to take a wheel undercarriage, and was produced as a landplane afterwards. In addition to giving the designers valuable data for the large flying boats, the Scion Senior was quite a useful light commercial type in both its versions. At a gross weight of 5,650lb. the seaplane version had a top speed of 134 m.p.h. and the landplane 140 m.p.h.

"Flight" photographs.

The Short Scion Senior (upper picture) served as a flying scale model of the Empire boats. It had four 90 h.p. Pobjoy Niagara engines. It was first produced as a seaplane, afterwards as a landplane. The lower picture shows Mercury and Maia, components of the Short-Mayo composite. Mercury had four 350 h.p. Napier Rapier engines. The aerodynamic cleanness is remarkable for a seaplane, but would have been even greater had it been possible to make the machine a landplane with retractable undercarriage.

The first Short four-engined monoplane flying boats built for Imperial Airways became known as the Empire class, from the fact that they were designed for the Empire air routes. Later on a slightly modified and strengthened version was introduced, which was known as the C-class. The main difference was that the gross weight was increased, as a result of overload trials with the Empire boats, from 40,500lb. to 46,000lb., it having been found that the earlier boats would get off quite comfortably with the extra load, so that provided the structure were designed for the greater load, there should be no operational objections to the increased load and range made possible by the new gross weight. By refuelling in the air this figure could be increased to 53,000lb.

The G-class Boats

Continuing the Short history of development, slightly out of chronological order in the general history of four-engined aircraft, the C-class boats were followed by the so-called G-class, which had an even greater gross weight (73,500lb.). There were other changes in design. For instance, the hull shape was different, the rear step having a vertical knife edge, much after the fashion of the hulls of the Sunderland military flying boat. The G-class boats had Bristol Hercules engines, giving a total of 5,520 h.p. for the take-off. The maximum speed was 209 m.p.h., and the maximum range 3,200 miles.

In the landplane category the Armstrong-Whitworth company had, in the meantime,

The Short Sunderland (below) brings us to the period of the present war. The similarity to the Empire boats is obvious. The engines are 900 h.p. Bristol Pegasus. The maximum speed is 210 m.p.h.

ENGLAND'S "FOURS"

A model of the Short 14/38 high-altitude commercial monoplane. Work had to be dropped when war broke out. The machine was to have four Bristol Hercules engines.

produced the Ensign (A.W. XXVII) commercial monoplane. It was fitted with four Armstrong Siddeley Tiger engines of 800 h.p. each, and had a maximum speed of over 200 m.p.h. The first machine appeared early in 1937 and had a gross weight of slightly more than 20 tons.

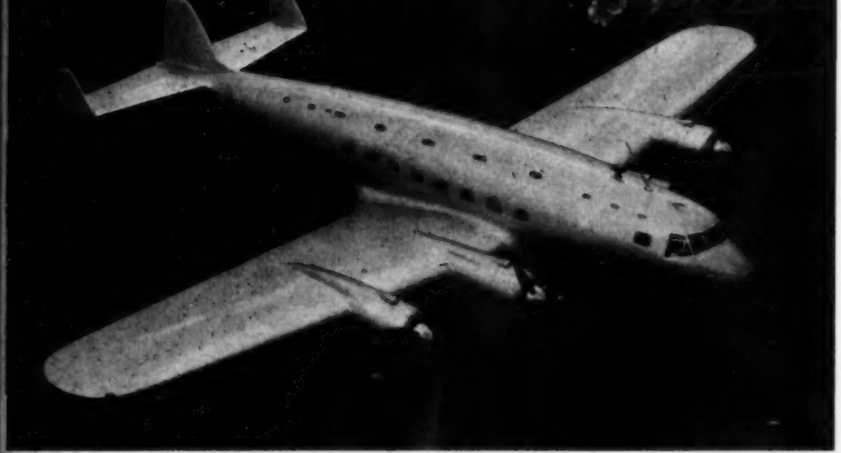
A Record-breaker

Brief mention might be made here of the very daring scheme for getting a small, highly-loaded aircraft into the air by carrying it on the back of a large, lightly loaded machine. The Short-Mayo composite, which appeared in 1937, consisted of a lower component (the Maia) rather similar to the Empire flying boats, on the wing of which was mounted a small twin-float seaplane, the Mercury. The latter was a very clean machine, with four Napier Rapier engines of 350 h.p. each, and had a cruising speed of about 190 m.p.h. The gross weight was 21,000lb., and the still-air range about 4,000 miles with a payload of 1,000lb. There is no doubt that a landplane with retractable undercarriage would have done even better, but Imperial Airways required the machine to be a seaplane. Even as a seaplane the machine did remarkably well. Its laurels included a non-stop flight from Foynes, in Ireland, to Montreal, Canada, and a world's record flight from Dundee, Scotland, to Orange River, South Africa. The latter distance was 6,045 miles. On that occasion the machine did not, of course, carry any payload.

In May of 1937 appeared a landplane of quite unusual interest, the De Havilland D.H.91. This was a very clean four-engined landplane powered by four De Havilland Gipsy-Twelve engines, each giving 530 h.p. for the take-off. The maximum speed was 225 m.p.h. at 8,750ft., at a gross weight of 29,500lb. A long-range mailplane version weighed 32,500lb. gross and had a slightly lower speed, 222 m.p.h. The first machine of the class was named Albatross, and the type was probably the cleanest landplane ever produced, certainly in the four-engined class.

Mention of the Short Sunderland was made in the reference to the G-class commercial flying boats. The machine made its first appearance in the early part of 1938. It was fitted with four Bristol Pegasus engines which gave about 1,000 h.p. each for the take-off. The normal gross weight was 45,700lb., and the maximum overload gross weight 49,870lb. The maximum speed was 210 m.p.h. at 6,250ft. The type, with minor modifications as to engine series, is still in service and doing excellent work.

Foreseeing that high-altitude flying might be the next step in commercial development, the British Government placed orders, some time before the outbreak of war, with two British aircraft firms for landplanes with pressure cabins and fully supercharged engines. One order was en-



The Fairey F.C.1 (left) was to have been another high-altitude machine with pressure cabin. The engines were to be Bristol Taurus of 1,000 h.p. each.

The Saunders-Roe Saro 37 (below) was a flying scale model of a much larger boat. It had four 90 h.p. Pobjoy Niagara engines. The full-size boat was built but did not go into production.

"Flight" photographs.

ENGLAND'S "FOURS"

trusted to the Short firm and the other placed with the Fairey Company.

Of the three monoplanes ordered from Shorts, two were to be ordinary commercial types, while the third, similar in a general way but equipped for sub-stratosphere flying, was to be a special experiment. The class was known as the Short 14/38 and the high-altitude version was to have special Bristol Hercules engines fitted with turbo-blowers which would give the engines a maximum economical power of 850 h.p. each, at 25,000ft. It was estimated that the gross weight would be 71,000lb., and the calculated range in still air was 3,390 miles at a cruising speed of 275 m.p.h., and 3,750 miles at 238 m.p.h. Against a 30 m.p.h. head wind the ranges at these two cruising speeds became 3,000 miles and 3,300 miles respectively.

Twelve monoplanes with pressure cabins were ordered by the Air Ministry from the Fairey Aviation Co. They were to be a good deal smaller than the Shorts, the estimated gross weight being 42,000lb. The engines to be used were four Bristol Taurus of approximately 1,000 h.p. each. For a range of 1,700 miles the estimated pay load was 4,500lb., and if the range were reduced to 500 miles the pay load increased to 9,500lb. The estimated cruising speed was 220 m.p.h. Twelve of these machines were ordered, and it had been expected that the first would be flying in 1940. The war stopped the project. The normal passenger accommodation was to be for thirty. For the longer ranges this number was to be reduced, and sleeping accommodation provided.

This review of British four-engined types has now brought us to the bombers in use at the present time. So far details have been disclosed of but two of these, the Handley Page Halifax and the Short Stirling, although mention has been made of a third, the Avro Lancaster, which is also to be built in Canada.

"Flight" photograph.

The Handley Page Halifax heavy bomber marks a long step forward since the V 1500 was produced in 1918 (picture on page *c*). The engines are Rolls-Royce Merlins.

The Halifax, like the Stirling, has been designed to specification which demanded that the wing span must be kept below 100ft. The power plant comprises four Rolls-Royce Merlin engines, and the bomb load is known to be very large, although no figures have been published. No speed figures have been quoted.

The Stirling, of approximately the same span and therefore probably of about the same wing area, has a maximum speed in the neighbourhood of 300 m.p.h., a maximum range of 2,000 miles, and a bomb capacity of 8 tons.

"Flight" photograph.

The heaviest of heavies, the Short Stirling, has a maximum range of over 2,000 miles, and a maximum bomb load of about 8 tons. The engines are 1,600 h.p. Bristol Hercules, which give a maximum speed of about 300 m.p.h.

SIMPLIFIED CRUISING CONTROL

How Some American Air Lines Make Things Easier for Their Pilots by Adopting Constant B.M.E.P. Operation

By ALLAN A. BARRIE and JOHN B. CUTTING

THIS article, for which we are indebted to our New York contemporary, "Aviation," deals with American air line operation, but fuel economy is even more important in long-range bombing, so that the lessons drawn and the conclusions reached should be of considerable interest to pilots of the R.A.F., particularly those of Bomber and Coastal Commands. The authors are on the technical staffs of Western Air Lines and Pratt & Whitney Aircraft respectively.

INTRODUCTION of the constant-speed propeller has made it possible to operate aircraft engines at constant B.M.E.P., which results in substantial operating economies. Several airlines use the constant B.M.E.P. method of operation, varying the propeller pitch and carburettor throttle opening and mixture control to attain the desired result. But it has not been easy to provide the operating crews with data easily used in the cockpit of the aircraft which would make it possible for the desired constant B.M.E.P. to be maintained under all flight conditions.

When Western Air Lines brought its power-plant equipment up to date with Pratt and Whitney Twin-Wasp R-1830

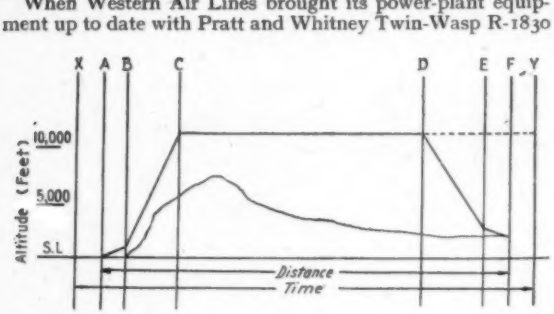


Fig. 1. The seven divisions of flight between Los Angeles and Las Vegas.

S1C3-G engines, it was decided to bring the operating technique abreast of the equipment. In the past most airlines have followed an operating procedure somewhat along the lines described by E. T. Allen and Dr. W. Bailey Oswald, in a series of articles entitled "Operation at Desired Cruising Conditions," published in *Aviation* magazine in February and April, 1934. At the time these articles were published the constant-speed propeller had not come into the picture. The introduction of the constant-speed propeller has separated the interdependence of manifold pressure and r.p.m., and allows an infinite combination of these quantities in achieving the desired constant B.M.E.P.

Using High B.M.E.P.

It must be understood that the ideal condition is to operate not only at a constant B.M.E.P., but at the highest B.M.E.P. which the fuel normally used will permit. Of course, we are not interested in B.M.E.P. as such. What we want to do is to translate engine power into aircraft performance over the usable range of the equipment. A concrete illustration will assist us in visualising this problem.

The flight from Los Angeles, Calif., to Las Vegas, Nev., a distance of 252 miles, is scheduled by Western Air Lines to consume 1 hr. and 35 min., using Douglas DC-3 aircraft with the Pratt and Whitney Twin-Wasp engines previously mentioned. We divide this flight into seven parts, as shown in Fig. 1, as follows:

X-A From blocks to take-off point
A-B Take-off and climb to 500ft.
B-C Cruising Climb.
C-D Cruise.
D-E Cruising descent to 500ft.
E-F Approach and landing.
F-Y Taxi to blocks.

The first three phases of the flight, because of their fixed procedure, do not offer the pilot a means of controlling his time of arrival at destination. In fact, variations here that are outside the pilot's control must be deferred to the later portions of the flight which are amenable to control. A late passenger delays the departure from the blocks. Traffic conditions may hold the aircraft on the ground several minutes longer than is allocated to "no progress" time. Up to the time the aircraft reaches cruising altitude nothing can be done to make up for these delays.

Fixed Procedure

However, Western Air Lines' procedure has been arranged to minimise the effect of these delays. Nine minutes is allowed in the schedule for taxi-ing, take-off and climb to 500ft., with a half-turn bringing the aircraft even with the field and headed on the route. Terrain conditions dictate a minimum cruising altitude, so the climb is standardised and it can be predicted that a 19-min. cruising climb will bring us to point "C" in Fig. 1, which is over Palmdale, Calif. Up to now the pilot has been following a procedure which is not varied. Hence, 28 min. after leaving the blocks, the aircraft is at 11,000ft. and 46 miles (plus or minus the wind) on its way. This procedure simplifies the calculating required of the crew during the early stages of the flight. After this point cruising control can be exercised. We must make the next 206 miles in the remainder of the time allowed. This distance includes cruise, descent and approach, all involving variations in the speed of the aircraft.

Here another practical short cut, proven over long experience, is used. We consider the remainder of the trip, including approach and taxi-ing, to be the same as continuous cruise. In Fig. 1 the total time consumed in descent (D-E), approach (E-F), and taxi-ing (F-Y) is the same as though the cruise line (C-D) were continued to form the line (C-Y). In other words, the increased speed

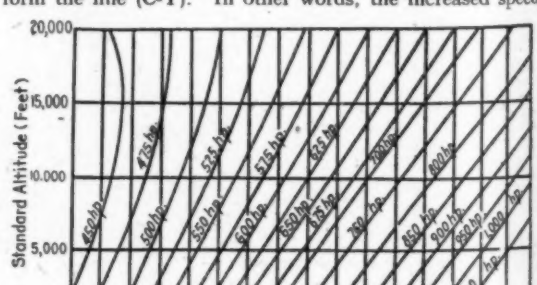


Fig. 2. Engine b.h.p. required, plotted against true airspeed and altitude.

of descent is closely balanced by the time required to approach the field and taxi to the blocks. So, in our example, the pilot completes his calculation by dividing the remaining 206 miles by the time left, 1 hr. 7 min., giving a required true airspeed of 184 m.p.h. Referring to Fig. 8, we select the engine setting giving us 185 m.p.h. true airspeed at 11,000ft. alt., or 1,860 r.p.m. with full throttle, which will result in an indicated airspeed of 153 m.p.h. A glance at the table and the pilot's information is complete. This engine setting is maintained to the point where the descent is completed, or Point "F."

This cruising control table combines in one readily usable form information that usually is supplied in three separate graphs. The procedure for developing this table is as follows:

1. From the aircraft manufacturer is obtained the chart shown in Fig. 2, which gives the engine brake horse-power required against true airspeed and altitude.

2. From the engine manufacturer is obtained the chart shown in Fig. 3, which gives the r.p.m. and manifold pressure characteristics against power and altitude.

3. We combine these two charts in Fig. 4. In this

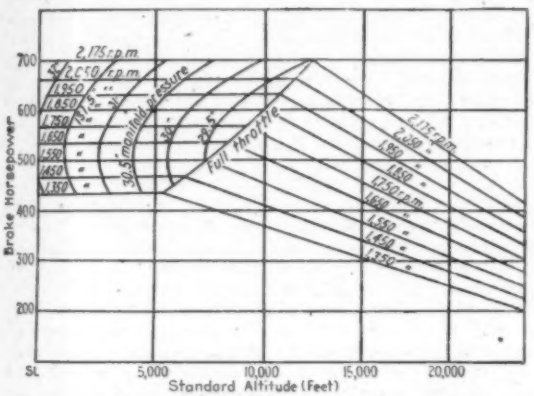


Fig. 3. R.P.M. and manifold pressure plotted against b.h.p. and altitude.

instance, cruising power is based on constant B.M.E.P., consequently below full throttle each constant-power line calls for a constant r.p.m. below the critical altitude for the selected B.M.E.P. This critical altitude shows in Fig. 4 as the full-throttle line. Above this line operation is at full throttle and diminishing B.M.E.P.

4. From the aircraft manufacturer we also obtain the airspeed indicator calibration shown in Fig. 5. Combining this with the fuel consumption curve of Fig. 6 and adding these to Fig. 4, we obtain the cartographer's dream shown in Fig. 7. It is believed that no essential information has been neglected.

Graphical Information

The use of constant B.M.E.P. for cruise was decided upon after consultation with the engine manufacturer. It was recommended as the operating method giving the maximum of engine efficiency and dependability. However, the chart could be so constructed that the same complete information given would be based on constant r.p.m. operation. The essential efficiency of this graph is that it gives the cruising information specifically for the complete range of conditions.

To satisfy the requirements of cockpit use a further step was made by tabulating the information given in Fig. 7, resulting in the table shown in Fig. 8. This has been found to be more readily usable under actual flight conditions than a graph. This table, printed on a page 8¾ by 11in., is pasted on the back of the flight plan board, which allows complete operating information to be obtained from two pieces of paper, back to back. Specific instructions for all allowable cruising conditions are readily available.

The construction of this table involves nothing new. However, the manner in which this information is applied may appear to violate some commonly accepted concepts of accuracy. The engine settings shown on the table are used directly without correction for density altitude or effect of carburettor air temperature on power. Also, the effect of weight variation on aircraft performance is ignored. The correctness of this procedure can be demonstrated by an engineering analysis of our flight as follows:

Assuming: altitude 11,000ft., temperature 53 deg. F., required true airspeed 185 m.p.h. Referring to Fig. 7, 185 m.p.h. at 11,000ft. will require 579 h.p. However, our density altitude is 13,000ft. and our engine power is reduced to 554 h.p. because of the high carburettor air temperature. At 13,000ft. 554 h.p. will result in 183 m.p.h., according to calculations. Actually, our aircraft controverted these laws by doing 185 m.p.h., possibly because under such temperature conditions we are not carrying de-icers.

Negligible Variables

The effect of weight on performance also is usually considered a tangible item requiring another calculation on the part of the crew in order to achieve accuracy. But the small errors introduced by these factors affect only true airspeed and are negligible in normal airline operations when weighed against the factors which are outside the pilot's ability to evaluate or control. A few such items are: tolerance of balloon-run data, tolerance of engine instrument calibrations, atmospheric turbulence, variation of engine power with mixture strength and humidity. In the past we have required the utmost precision from the pilot concerning variables which will exert an influence of but one-half of one per cent. on performance while ignoring variables affecting performance as much as 3 per cent.

Our crew, having set the engines at 1,860 r.p.m. and full throttle, will continue to the next check point, and the accuracy of the original setting will then have been determined. Perhaps the expected zero wind is a 3 m.p.h. delaying wind, and the speed must be stepped up to 190 m.p.h. for the remainder of the trip. A quick reference to the chart will give the figure of 1,910 r.p.m., still full throttle, and a resulting indicated airspeed of approximately 155 m.p.h. The pilot knows he is still operating his engines properly, yet he has not been required to spend any time on calculating his problem. From here we can confidently expect arrival at Las Vegas within a minute of estimate without further attention to the engines.

It would be well to add here that the instrument indications by which the crew determines the aircraft performance are read with a tolerance that would upset an engineer. Because of the position of the instrument with relation to the pilot and co-pilot, the tachometer indication is anyone's guess plus or minus 10 r.p.m. Similarly, the manifold pressure is never read more closely than 0.25 in. Hg., and the indicated airspeed is referred to in increments of 5 m.p.h. We believe this to be true of other operators using similar equipment.

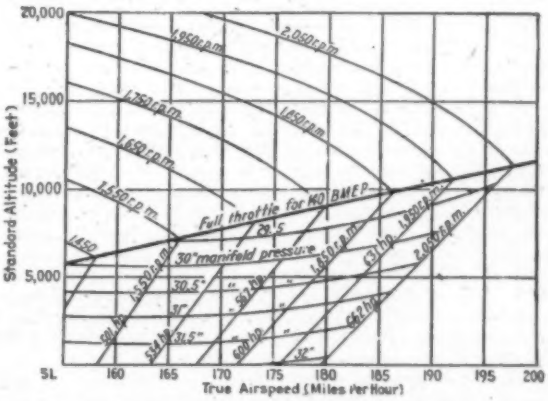


Fig. 4. This graph is a combination of Figs. 2 and 3.

SIMPLIFIED CRUISING CONTROL

In spite of these apparent inaccuracies, precision is obtained primarily because of the experience of the crew, and, secondly, because these apparent inaccuracies tend to cancel one another. An example of this is the effect of varying gross weight. At constant gross weight our aircraft will be 2 m.p.h. fast in summer and 2 m.p.h. slow in winter. However, summer loads will tend to slow the aircraft down to the standard, and lighter traffic will compensate in like manner.

We find that a high degree of accuracy has been obtained by regarding this table as a guide to true airspeed. The real precision must come from the attention of the crew to ground speed. Prior to the introduction of this technique, we could expect a difference of three minutes in actual arrival time from the pilot's original estimate in a flight of 250 miles. This was while using equipment which was operated on constant power and with no attempt to control arrival time while in flight. This difference in 650

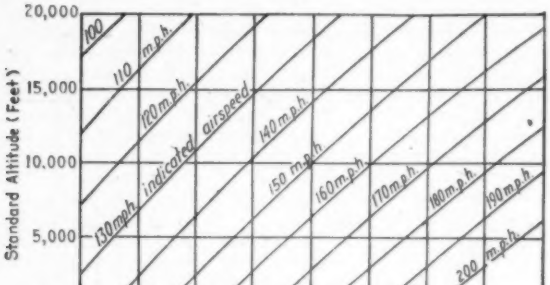


Fig. 5. Indicated airspeed calibrated with altitude and true airspeed.

miles amounted to as much as five minutes. Because of the inflexible operating technique then used, these differences can be ascribed to the variable accuracy of balloon-run information. To-day we are meeting our original estimates within one minute because the crew has available the necessary information to control cruising performance.

The emphasis placed on indicated airspeed is at variance with the policy of some operators. The usual objection to using this instrument as a basis for navigation is the possible tolerance of its indication. For a high degree of instrument accuracy, frequent flight calibrations would be necessary.

As previously shown, we accept a comparatively wide tolerance in the airspeed indication, but are convinced that the data of this degree of accuracy is valuable. This instrument gives the pilot the most tangible evidence that the power expended is resulting in the expected performance. The table is sufficiently accurate so that the three factors tabulated, r.p.m., manifold pressure, and indicated airspeed, fall together as a unit within the accuracy that these gauges are read. This one fact alone has been a large factor in gaining the pilot's acceptance of these instructions. The major purpose of the instructions, as previously stated, is to translate engine power into aircraft performance. The engine power, as determined by r.p.m. and manifold pressure, is translated into aircraft performance as measured by the airspeed indicator.

An interesting by-product has resulted in having these three readings so closely related. As the personnel expect to have these related readings come together, the variation of any one is a quick indication of ice formation. For instance, if at 10,000ft. we have 1,940 r.p.m. and 29.25in. manifold pressure and indicated 150 m.p.h. instead of 160 m.p.h., we look for ice on the wings or pitot head. Similarly, a drop in manifold pressure will give a warning of engine ice. It is true that these conditions would be manifested otherwise, but because the crew expects these three quantities to line up as shown in the table they are more quickly aware of adverse conditions if one quantity is out of line.

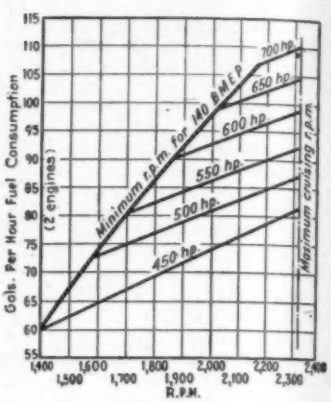


Fig. 6. Fuel consumption curve.

Experience has dictated the limits of cruising control. A true airspeed of 195 m.p.h. at 2,050 r.p.m., or 630 h.p., is the maximum. This is governed by considerations of practical engine limitations. Exceeding this power will result in rapidly increasing maintenance costs. The minimum is 135 m.p.h. indicated airspeed., At speeds lower than this the aircraft is too slow to react for continuous flying. Therefore, if our headwind is too great, we fly at 195 m.p.h. true airspeed and arrive behind schedule. If the favouring wind is sufficiently great we arrive ahead of time, despite operating at minimum allowable cruising speed. Within these limits we exert all possible means to maintain schedules, as precision of operation creates a favourable impression with customers. One factor assisting in adherence to schedule is that the required average speed leaves a sufficient margin of power to compensate for normal delaying winds and ground delays.

Where favouring winds exist the aircraft is accordingly slowed down. This policy may be objected to by some operators who prefer to take advantage of favourable winds by arriving at the next destination ahead of schedule, arguing that costs are calculated on the basis of hours flown. However, as departure from the next stop can seldom be made ahead of schedule, the irritation of the passengers resulting from the increased length of time on the ground is a factor that must be considered. With constant high B.M.E.P. operation we achieve the speeds required by the schedule with maximum fuel economy for the desired airspeed.

Fuel Economy

All that has been said above applies directly to continental airline operations where flights are relatively short and maintenance of schedules is a major factor. However, in long transoceanic flights the requirement of maintaining scheduled time is secondary to achieving the maximum fuel

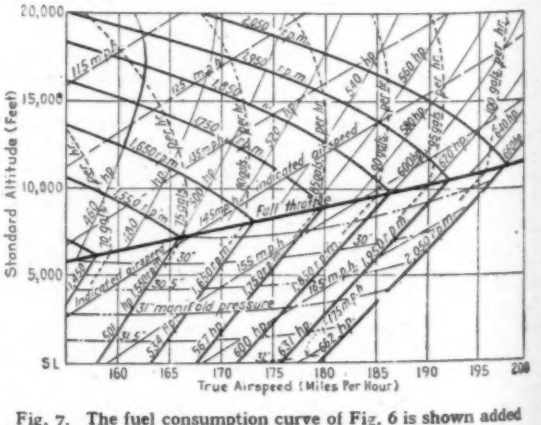


Fig. 7. The fuel consumption curve of Fig. 6 is shown added to the chart of Fig. 4.

True Air Speed, in Miles per Hour												Standard Temp. °F.	Altitude in Feet	True Air Speed, in Miles per Hour											
160			165			170			175					180			185			190			195		
RPM	MP	IAS	RPM	MP	IAS	RPM	MP	IAS	RPM	MP	IAS			RPM	MP	IAS	RPM	MP	IAS	RPM	MP	IAS	RPM	MP	IAS
												−8.5	19,000												
												−5	18,000												
												−2	17,000												
												2	16,000				2030	24.4	146						
1750	23.4	121	1790	23.7	125	1830	24.0	129	1880	24.3	134	5·5	15,000	1940	24.7	138	2000	25.0	143	2050	25.6	147			
1710	24.1	123	1750	24.4	128	1800	24.6	132	1850	24.8	136	9	14,000	1910	25.2	141	1970	25.7	145	2025	26.3	149			
1660	24.8	126	1710	25.0	130	1760	25.2	134	1815	25.6	138	12.5	13,000	1870	26.0	143	1925	26.4	147	1980	27.0	152	2050	27.6	157
1640	25.3	127	1680	25.7	132	1725	26.0	136	1780	26.3	141	16	12,000	1840	26.7	146	1900	27.2	150	1960	27.8	155	2025	28.4	159
1600	26.1	130	1650	26.4	134	1700	26.7	139	1750	27.0	144	19	11,000	1810	27.5	148	1870	28.0	153	1940	28.6	157	2000	29.25	162
1570	26.8	133	1615	27.2	137	1670	27.5	141	1725	27.8	146	23	10,000	1775	28.3	151	1840	28.9	155	1940	29.25	160	2045	29.5	165
																		(Wide open Throttle)							
1540	27.6	134	1590	28.0	139	1640	28.3	144	1700	28.7	148	26.5	9,000	1765	29.25	153	1860	29.25	158	1970	29.5	163			
1530	28.4	137	1560		141	1610	29 1	140	1700	29.25	151	30	8,000	1790	29.5	156	1890	29.75	160	2000	29.75	166			
			(Wide open Throttle)																						
1490	29.2	139	1550	29.5	144	1630	29.5	149	1730	29.75	154	34	7,000	1825	29.75	158	1950	30.0	163	2045	30.25	168			
1480	29.75	141	1565	29.75	147	1650	29.75	151	1750	30.0	156	37	6,000	1850	30.25	161	1960	30.25	166						
1500	30.25	144	1580	30.25	149	1670	30.25	154	1770	30.25	158	41·5	5,000	1875	30.5	164	2000	30.75	169						
1510	30.5	147	1600	30.5	152	1700	30.75	157	1800	30.75	162	45	4,000	1920	31.0	167	2045	31.25	172						
1530	30.75	149	1620	31.0	154	1735	31.0	159	1830	31.0	165	48·5	3,000	1950	31.25	170									
1550	31.25	152	1645	31.25	156	1750	31.25	162	1865	31.5	167	52	2,000	1980	31.5	173									
1570	31.5	154	1670	31.5	159	1775	31.75	165	1900	31.75	170	56·5	1,000	2040	32.0	175									
1585	31.7	157	1700	31.75	162	1800	32.0	167	1950	32.0	173	59	Sea Level												

Fig. 8. The information of Fig. 7 is shown here in tabular form. Cruising chart for Douglas DC-3 and DST-A airplanes, based on P & W S1C3G engines with Stromberg PD12B8 injection type carburetters and hydromatic propellers, geared 16 to 9, using 140 B.M.E.P. with 90 octane fuel. Table designed for standard conditions. MP is manifold pressure. IAS is indicated air speed.

economy possible with the aircraft and engine combination being used. The result is that such operations are usually conducted at the maximum range condition of the aircraft, regardless of over-water speed. This is essential from the standpoint of maintaining a large margin of reserve fuel and also to avoid carrying excessive fuel, which would reduce pay-load.

For scheduled airline operations over land the new operating technique described above has been used for more than a year and sufficient experience has accumulated to warrant the following conclusions:

1. The main benefit derived has been the simplification of the pilot's cruising calculations. He has readily available in flight accurate and definite instructions for obtaining the desired aircraft performance, which, in its entire range, is within engine limits.

2. Whereas the fuel savings anticipated from the use of a high-constant B.M.E.P. have not been definitely apparent, it is felt that Western Air Lines has done well to hold fuel consumption constant. Increased ground delays and traffic upsets attendant on the increasing defence activities of the past year would have increased the amount of fuel used under previous methods.

3. The average operation has been accomplished at a reduction in engine speed of about 200 r.p.m., even though at the same average power as previously used. The resultant decrease in cylinder and piston wear alone makes this method of operation desirable.

4. The slower engine speed provides a quieter cabin, which is appreciated by passengers, especially on sleeper runs.

5. As a result of the high B.M.E.P. feature of the operation, we have found that the greatest care must be given to the ignition system. An engine and propeller in excellent condition will operate through all cruising speeds of from 1,500 to 2,050 r.p.m. without vibration. However, this type of operation does make more readily apparent any deficiency coming from the ignition harness or spark plugs, and will not allow the magnitude of propeller unbalance tolerable with operation at lower B.M.E.P.

Where vibration from one of these sources begins to develop in flight, it has been the rule to reduce the manifold pressure by 2in. Hg., change the mixture to automatic rich and select a different r.p.m. which will move the engine speed out of the vibration range and allow a safe flight to the next station.

Perhaps the best summation of the description of Western Air Lines' method of cruise control is that the pilots like it, use it, and make it do what its originators intended it to do.

CREW COMFORT IN MARS

World's Largest Flying Boat has Wardroom and Bathrooms

LATEST information about the XPB2M-1, the giant flying boat built by Glenn L. Martin for the U.S. Navy, shows that particular attention has been paid to the comfort and convenience of the air crew.

According to a report released by the makers for publication, this aircraft, which has a span of 200ft. and an overall length of 170ft., not only has sleeping accommodation for 13 men (its normal crew will number 11), but provides a wardroom for its officers, separate messes for officers and "ratings," and a private stateroom for the captain.

In sea-going craft it is traditional for the crew's quarters to be located "forrard," but in this flying boat they are located aft, the officers' quarters occupying the forward part of the hull. The respective messes, however, are served from the same galley.

Another refinement is the provision of two separate shower-baths, fore and aft, for officers and ratings respectively. There are also rest and recreation spaces aft for the use of the men, and plenty of room for them to stretch their legs in strolls along the full-length aisle of the lower deck, which measures 117ft.

"All this does not even take into account the great void of the tail," runs the report, "which in a commercial version would be utilised as living and storage space."

From the level of the upper deck a ladder leads into the wing in which passage-ways run out to the four engine nacelles giving access to the rear of the power-units which may thus be inspected and serviced in flight. Incidentally, the wing is six feet thick at its maximum section, so that one can walk upright along the passage-ways.

Staircases connect the two decks, and on the flight-deck (which is equivalent to the bridge of a ship) the captain has his private desk.

The combat stations include six power-operated gun turrets, but the actual armament is not disclosed. A further idea of the aircraft's size is given by the statement that the total volume of the hull alone is 16,665 cu. ft., which is about equivalent to a 15-roomed house. Even the wing-tip floats are as big as fair-sized motor boats.

BEHIND THE LINES

Service and Industrial News from the Inside of Axis and Enemy-occupied Countries

From Finland and Rumania

IN *Flight* of January 15th brief details were given of the equipment of Hungarian and Slovakian squadrons operating with the *Luftwaffe* on the Russian front.

Apparently the Nazis consider German equipment too precious to be entrusted into the hands of their non-Teutonic allies. The small Air Forces which Finland and Rumania have thrown into the battle against Russia employ equipment purchased before the war or procured afterwards from "special" sources.

Finland's fighter squadrons use the Fokker D-21, a single-seater low-wing cantilever monoplane. The fuselage of this type is of welded chrome-molybdenum steel tubes.

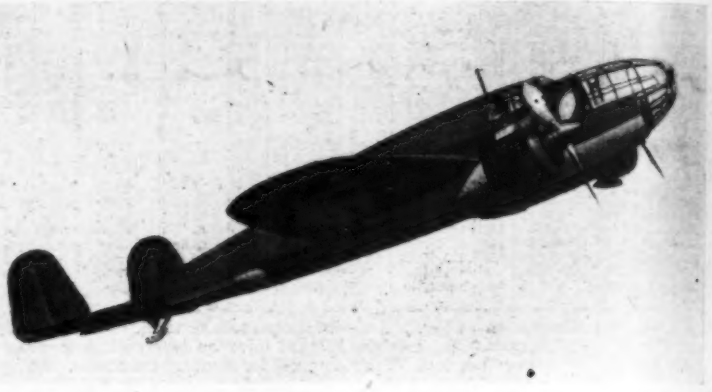
From the nose back to the trailing edge of the wing the forward part of the fuselage as well as its upper surface is covered with quickly detachable dural and aluminium sheets. The remainder is fabric covered. Wings are in the usual Fokker manner, built with two box spars and plywood ribs and with a bakelite plywood covering.

It is powered with various types of air- or liquid-cooled engines of 600 to 1,000 h.p. The armament of the fighter comprises either four machine guns (two in the fuselage and two in the wings) or two machine guns and two cannons, according to the type of engine installed.

Polish Łos

THE Rumanian squadrons employ a Polish bomber, the P.Z.L. 37 "Łos." This is an all-metal monoplane powered with two Bristol Pegasus XX or Gnome-Rhone engines of 900 to 1,050 h.p. and is armed with three mobile machine guns and carries a bomb load of approximately 5,000 lb. The range with a bomb load of 3,500 lb. is 1,100 miles.

The sources from which Goering's Rumanian accomplices have procured this bomber appear to be different. After the collapse of Polish resistance most of the remaining aircraft were flown to Rumania, which was then an ally of Poland. If the "Łos" is among these machines, which have since been appropriated by the Rumanians, their number must be insignificant, for the Polish Air Force never had more than 40 or 50 machines of this type in service. It is, however, possible that the Polish factory, which was not destroyed, has been again put on production of this type. That would be the obvious thing to do to avoid delay.



POLAND'S LAST: The "Łos" bomber in service with the Axis. It is one of the few aircraft delivered by the Polish Air Force to their one-time Rumanian allies.

A New Mauser

MESSERSCHMITT fighters are known to have been gradually re-equipped with a type of cannon constructed by the well-known makers of Mauser automatics. The new cannon is of 20 mm. calibre and is said to have a fire power of 900 rounds per minute.

ANOTHER SWASTIKA: A Fokker D-21 fighter flown by Finnish squadrons on the Russian front.

From the Russian Front

THE Russian Press reports the following German types of aircraft encountered recently by the Soviet Air Force:—

A Dornier twin-engine fighter, the Do-29, with a speed of approximately 330 m.p.h.

The Me-115 single-seater fighter, a slightly smaller version of the Me-109, powered with the Mercedes-Benz of 1,600 h.p. Approximate speed 397 m.p.h.

The Me-209, powered with a D.B. 603 12-cylinder engine of 1,470 h.p., whose maximum speed at 19,000 ft. is said to be 390 m.p.h. The armament comprises four guns (15 mm.) in wings and two synchronised machine guns.

A Heinkel He-177 4-engine bomber, with a tandem arrangement of engines according to a Heinkel patent obtained some time ago. The estimated maximum speed is slightly over 270 m.p.h. with a bomb load of 6,600 lbs., and a range of about 1,600 miles.

Italian Training

A NEW decree empowers the Air Ministry to conduct training courses for young men between the ages of 18 and 26. The students enlisted in these courses will be selected from officer cadets of the Army reserve, and will undergo instruction for a period of 18 months. Selected candidates have to undertake to remain with this service after qualifying for the flying licence and to participate in exercises totalling at least six months. The Italian equivalent to matriculation, physical fitness and political integrity are the necessary qualifications for acceptance.

Spitfires of the Belgian squadron taxying out to give an excellent display of formation flying. A solo effort by one of the Belgian pilots was most impressive.

A FAMOUS STANDARD

Belgian Squadron of Fighter Command Receives King Albert's Colours

AT a fighter station last week the first all-Belgian fighter squadron of the R.A.F. was presented with the colours given to one of the original Belgian squadrons by King Albert. In the presence of representatives of all the allied nations, M. Camille Gutt, Belgian Minister for National Defence, put the flag into the hands of Col. Wouters, Commandant of Belgian Military Aviation, with these words: "I am giving into your keeping the flag of the regiment of the Belgian Aviation. This flag, after May, 1940, had been kept in occupied territory. A Belgian aviator left here a few weeks ago to fetch it back. Last month, another officer brought back the lion of the flag-pole from Belgium. I thank both of them.

"Flag of our Aviation, in days gone by you waved in freedom over a Belgium that was peaceful, independent and loyal. For over a year you lay in the soil trampled by the enemy till one day, when a Belgian hand came to wrench you from your place, that you might once again be unfurled in the sunshine of liberty.

"Flag of our Aviation! For all of us you evoke our Motherland, crushed to-day, never in subjection, to-morrow free!"

(Left) UNFURLED: The flag—which has since 1940 remained hidden in a shell case in a Belgian wood—is used again for the ceremony of Taking the Oath. Battle honours on the flag include Yser, Flanders, Antwerp, Liège and Namur. (Below) M. Gutt pinning the Croix de Guerre on Wing Cdr. J. Rankin, D.F.C., who, with Sqn. Ldr. Gilroy, who also received the Croix de Guerre, has led many formations of Belgian pilots.

THE MILES MASTER III

New Advanced R.A.F. Trainer with American Engine

THE latest advanced trainer to be taken into service by the R.A.F. is the Miles Master III. This machine—a low wing monoplane—is similar in design to the Master II, but is powered with a Pratt & Whitney Twin Wasp Junior S.B.4G. engine.

This engine, which is of slightly larger cubic capacity than the Bristol Mercury fitted to the Master II, has 14 cylinders arranged in a double row (the Mercury, of course, is a 9-cyl. single-row unit), with an international rating of 750 h.p. and develolping 825 h.p. for take-off. It is slightly heavier than the Mercury, but, against that, its diameter is only 44½in. as compared with the 55.5in. circumference of the Mercury, so the small increase in weight is more than offset by the appreciable reduction in drag.

In all but top speed, the performance is comparable to the present-day fighters, and the flying characteristics are very similar. The wing loading, for example, is the same as that of the Spitfire.

The Pratt & Whitney Twin-Wasp Junior (SB-4G) 14 cylinder engine makes a neat installation on the nose of the Miles Master. A De Havilland controllable-pitch airscrew is fitted.

The Master III is built of wood—spruce members covered with three ply—which gives a rigid structure. It is designed to provide training in bombing, gunnery, navigation, high-speed flying and instrument flying. The operational equipment may be varied to suit the particular type of instruction required. Except for navigational training, the pupil occupies the front cockpit, which is fitted with an instrument-flying hood.

Advantages of Wood

Metal has long been the only material used in the R.A.F. for high-performance aircraft, but wood, for a high-performance trainer, retains its advantages in the Miles type of machine. The same strength and safety factors are there, the wood aircraft is often easier to repair, and there is unlikely to be a shortage of this material. There is thus no competition with important Service needs for metal.

The wings are fitted with hydraulically operated flaps, and the depth of the centre section accommodates the fuel tanks and undercarriage in its retracted position.

The front cockpit hood slides aft on rollers, and is fitted with a push-out panel for use should the view through the windscreen become obscured. The rear cockpit hooding incorporates hinged side panels and a roof panel which can be tilted to form a windscreen for the occupant of the cockpit. The portion of the hooding between the cockpits is specially constructed of metal to form a crash frame for the protection of the crew in the event of the aeroplane overturning on the ground.

Details

Span	39ft. 0in.
Height (tail down)	9ft. 3in.
Length (tail up)	30ft. 2in.
Undercarriage track	12ft. 4in.
Airscrew diameter	10ft. 0in.
Wing area (gross)	235 sq. ft.
All-up weight	5,400 lb.
Tare weight	4,210 lb.
Petrol	525 lb. (70 gallons)

Spotters will find it anything but easy to differentiate between the Pratt & Whitney engined Master III and its predecessor, the Mercury engined Master II, although the P. & W. is a twin-row engine some 11 inches smaller in diameter. The seat in the rear cockpit can be raised by the instructor, for landings, so that he can get a good view of his pupil's performance.

HERE AND THERE

Air Strengths

LAST autumn there were 210,000 officers and men in the U.S. Army Air Force, says *Life*. By June this number will be increased to 385,000, and the total is now to be expanded to a million men.

The same journal gives the strength of the R.A.F. as 500,000 men and the *Luftwaffe* as 1,000,000, but we question the accuracy of the figure given for the R.A.F. which, in any case, is secret.

Back from the Far East

HAVING escaped from Bangkok at the time of the Japanese occupation, the Honourable Leslie Runciman, director-general of British Overseas Airways, has just returned to this country after a five months' tour of inspection of the corporation's Empire and other services stretching from Africa, via Egypt, Iraq, and India as far as Burma and Thailand. He also visited Persia, Palestine, Eritrea and Abyssinia, and had a number of useful discussions with various authorities on the present and post-war possibilities of civil aviation.

Official Task Completed

MR. W. C. DEVEREUX has been released from his position as Controller of Repair and of American and Dominion Aircraft Supplies to resume control of High Duty Alloys, Ltd., and the other companies in his group engaged on the production of vital war materials.

When appointed by Col. Moore-Brabazon seven months ago, Mr. Devereux' task was to create an organisation capable of handling imported American aircraft and a similar organisation to handle the repair of aircraft engines, both British and American.

With this task completed, Mr. Devereux asked to be released to devote his energies once again to production matters. He has received letters of appreciation of his work from the Minister himself and also from other officials of the Ministry of Aircraft Production.

A.T.C. Birthday Greetings

THE Secretary of State for Air, Sir Archibald Sinclair, has sent a message to the Air Training Corps through its Commandant, Air Commodore A. J. Chamier, on the occasion of the first anniversary of its formation, in which he said, "The Air Training Corps reaches its first birthday with the knowledge that it has surmounted the perils of infancy and taken its place in the support line behind the Royal Air Force. The Corps offered boys a chance to learn the elements of flying and they have seized the chance with both hands. Since last February many thousands of Cadets have passed into the R.A.F. or the Fleet Air Arm, with their preliminary training already completed.

"To all of you who have thus shown your eagerness to play a man's part in your country's defence I offer my congratulations on the first year's work and my good wishes for the future. I am sure you would wish me also to express your thanks to your officers, instructors and other helpers, without whose devoted labours you could not reach your goal."

Motor Industry Fighter Fund

H. G. STARLEY, well known in the motor car industry, was really responsible for the successful launching of the Motor Industry Fighter Fund, which, aiming at £100,000 for a complete fighter squadron, closed with the satisfying total of £105,000.

The full story of this fund, of which Mr. Starley became organising secretary and William E. Rootes its president, is told in an attractive 32-page brochure (appropriately enclosed between covers of Air Force blue) which has just been circulated with the compliments of the president and committee.

It is beautifully printed and copiously illustrated on art paper and, since it relates to such a stout effort, perhaps one may turn the Nelsonian eye on the paper shortage for once.

But we confess to a slightly raised eyebrow at discovering that the diagram "showing some of the thousands of component parts of a Spitfire with the approximate cost" is, in sober fact, that of a Hurricane!

However, the idea itself was good.

Pin-point Navigation

IT was recently mentioned that, in navigating American bombers across the North Atlantic to this country, an error of seven degrees would cause the pilot to miss the British Isles altogether.

But the Qantas Empire Airways crews, who ferry Catalinas from America across the Pacific to Australia for the R.A.A.F., have to navigate with absolute pin-point accuracy to "hit" some of the intermediate islands now used as flying-boat bases, one of which is a coral island about four miles by three miles in dimensions.

CAPTAINS OF THE CLOUDS

A Film Dedicated to the R.C.A.F. : Many Admirable Flying Scenes : Photographed Throughout in Technicolour

IT is seldom that a film inspires a case-hardened critic with a desire to see it through again, but "Captain of the Clouds" falls into this rare category; it is a first-class production in almost every respect.

What will appeal most to readers of *Flight*, over and above the film's excellent technicolour photography, its many thrilling flying scenes and its quite entertaining story, is the fact that it is entirely free from those tiresome, irritating inaccuracies that have marred some of its forerunners.

You will not have the pleasant illusion of reality shattered for you by technical howlers that the average schoolboy could not fail to spot and, in that respect in particular, Warner Brothers are to be most heartily congratulated.

The film is dedicated to the R.C.A.F. and to the bush pilots, and although the story is a piece of screen fiction in which that lively little tough guy, James Cagney, plays the part of a Canadian bush pilot who joins the Royal Canadian Air Force, gets cashiered for a calamitous breach of discipline and ends by making the supreme sacrifice when an Atlantic ferry pilot, it cannot be charged against this film that the fictional aspect is merely an excescence upon its factual side.

It is true that the idea of the supposed bad boy vindicating himself in final self-sacrifice is anything but a new one, but this time the plot has too much sound human drama and has been too well built up for such a criticism to be worth levelling. Moreover, the sequences showing life on a big Canadian air training station are an essential part of the story and the two are of well-balanced importance in the production as a whole, thanks to intelligent direction.

Cagney gives the spirited kind of performance for which he is so well known, and Dennis Morgan, as the bush pilot who makes good in the R.C.A.F., gives a neat character study which runs true to type throughout. Air Marshal Billy Bishop, V.C., and Sqn. Ldr. O. Cathcart Jones, who also appear among a uniformly good cast of players, suggest that they might have been equally successful as actors had they chosen this profession in preference to flying.

In the language of the country, Warners have done a swell job.

James Cagney (left) with some 6,000 hours as a bush pilot, finds himself compelled to receive *ab initio* instruction from his arch-enemy (Dennis Morgan) on joining the R.C.A.F. The trainer is a Fleet Finch with 125 h.p. Kinner engine.

Correspondence

The Editor does not hold himself responsible for the views expressed by correspondents. The names and addresses of the writers, not necessarily for publication, must in all cases accompany letters.

THE TANK BUSTER

Difficult to Improve on Dive-bombing

A.A. guns must use a very high velocity not only to defeat the avoiding action of aircraft but also to reach the required height. A 6 lb. shell shot out at 4,000 f.p.s. possesses twice the energy of a 12 lb. shell at 2,000 f.p.s., but both will be accompanied by the same recoil. This energy equals *force* × *shift* and governs the rise against gravity or, in the case of anti-tank and naval guns, the piercing of armour. A shell exploding on the outer surface of armour does comparatively little damage.

Your correspondent, "Letusdo It First" (and do let us hit first), may like to be reminded of a lecture before the Royal Aeronautical Society on April 19th, 1940, in which S. Rogalski suggested the mounting of shell-guns in aircraft of a calibre comparable with A.A. guns and taking their place. The Battle of Britain showed later, however, that existing aircraft armament and A.A. *barrages* provided effective defence when used together.

The recoil mechanism of a gun only reduces the load on the mounting by spreading out the time during which the recoil momentum is sustained. This momentum equals *force* × *time* and must be transferred entirely to the aircraft carrying the gun and directly affects its movement. (I believe it is true that an early experiment with a shell-gun on a flying-boat reduced its speed to the stall every time a burst was fired forwards.)

This problem engaged the attention of inventors even during the last war, and in 1940 the French Air Ministry published some very interesting information in "Publications Scientifiques et Techniques du Ministère de l'Air—No. 157," describing devices ranging from rocket-propelled *aerial* torpedoes to a gun which threw off a weight backwards for every bullet fired forwards. The high-velocity shells from existing aircraft shell-guns are not to be despised against light tanks.

The only case of an external explosion effective against thick armour is a *marine* torpedo (naval or aircraft) when the surrounding water concentrates the force against the side of the ship. For "tank-busting" it seems difficult to improve on dive-bombing, which provides some of the desired speed for aiming, with bombs heavy enough to deal almost bodily with a tank.

R. C. ABEL.

NO NATIONAL MONOPOLY

"Carping Spirit" Must be Checked

IT is fortunate that Edward P. Warner's well-balanced views appear in your issue (February 6th) at the same time as the quotations extracted from the American Press, particularly when the "Man in the Street" is reading in our daily Press that the Buffaloes and other American aircraft are being out-manœuvred in Singapore, and note we were outclassed until the Hurricanes arrived.

He also reads, moreover, that mechanised equipment supplied from the U.S.A. which is being used in Libya is sharply criticised as being out-gunned and out of date.

These "rough-neck" Isolationist-inspired writers, unless checked, will completely upset the spirit of the Atlantic Charter and the co-operative efforts inaugurated by the Churchill-Roosevelt conferences; these same writers will slowly learn that announcements of "umpteen" million dollars for something to be made "sometime, never" does not kill Japs or Nazis.

I recently read in a Detroit newspaper, sent by an American friend, that the Rolls engines (now in production at the Packard plant) fitted to certain American fighters, have "boosted" up their performance at least 50 m.p.h. (actually, this important news was tucked away in the local items).

Having visited America since 1940, round about the "Battle of Britain" period, I am at a loss to understand the mentality of many of the writers, who have deprecated anything British and called them "yellow" in 1938 (Munich period).

Dying to the last Frenchman in 1939-40; Australians and New Zealanders (1940-41) doing all the African fighting; dying to the last Russian (late 1941)—do these scribes realise that the best blood of our race, our airmen, the fittest men in the world, have beaten the enemy in every case where they had anything like a sporting chance, often with the odds against them, and that we have and are losing them still by hundreds each week?

When over the "Pond," I met socially some of their best factory pilots, such as Major Dolittle, with whom I flew over a wide area and thousands of miles in their airliners, receiving kind consideration everywhere. But when outsiders, often of enemy origin or pro-Fascist, came in my path, they received better than was given at any time. I have the impression that too many of our English officials and essential business visitors do not "bare their teeth" when the occasion arises, but give the impression that we are a "done for" race; the real Yank likes "guts."

Every one of the R.A.F. laddies I have met who have been to the U.S.A. training schools have been well received, but this carping spirit of the few must be fought by others, who, like the writer, are not interested in the aviation business other than to see its ultimate travel-benefit for the human race in the new world to be.

W. J. LORD.

CAMERA CURIOSITY

Yet Another Theory Advanced

IN reply to your correspondent, R. H. Warring, ingenious though his suggestion is as to the cause of distortion of the lower blade in photographs of revolving propellers, the theory is based on a fallacy.

If Mr. Warring were to place a thin sheet of frosted glass or tissue paper in his camera where the film is normally situated, direct the camera towards an illuminated object, such as a candle flame, with the shutter open, he will observe an inverted image of the candle flame on the frosted glass or paper. If he then holds a thin pencil horizontally in front of and above the camera lens, close to the camera, and slowly lowers it, he will observe that the image of the candle flame on the frosted glass or tissue paper is merely lessened in intensity by the passage of the pencil. If Mr. Warring's theory were correct the image would be partially obliterated and a shadow would pass from one end of the image to the other.

The dimming of the image is due to the fact that an optical image will be formed complete even though the lens be partially covered. The intensity of brightness of the image will vary directly according to the area of the lens surface exposed. Now considering this last dictum, we may assume that the image on the camera film will first be dim, secondly bright and thirdly dim as the aperture of the shutter closes down, but in each case the image will be complete. Each end of the propeller is moving equally fast, therefore the "drawn-out" effect shown in the illustrations will be seen at both ends.

This disposes of the reason suggested for differences of appearance of the two ends of the airscrews, but I can advance an alternative theory for the appearance.

The source of illumination for the photographs is either direct sunshine or light diffused from the sky, therefore some surfaces will be in shadow and others lighted, since the two blades of the airscrew are not in the same plane. (I use the word in its mathematical sense.) Now, if the lighted side of the airscrew is photographed against a light background (*e.g.*, sky) it will come out comparatively invisible on the photograph while the dark side of the airscrew will stand out in silhouette against a light background.

WILLIAM CLEGG.

ISOLATED A.T.C. UNITS

SQUADRONS of the A.T.C. in the more isolated parts of the country invariably lack most of the amenities enjoyed by those in the big towns, and our attention has been called to a case in point by a letter from the O.C. of No. 77 Squadron, Redruth, Cornwall, which was started as long ago as March, 1939, as a unit of the Air Defence Cadet Corps.

This squadron is trying to build up a library, and would be grateful for old copies of *Flight* and other aviation journals, and for copies of books on flying, both technical and otherwise. Its address is County School, Redruth.

Service Aviation

Coastal Command have built up a reputation for carrying out operational flying whatever the weather. Our photograph shows aircraftmen removing snow from a Hudson.

Royal Air Force and Fleet Air Arm News and Announcements

Awards

THE KING has been graciously pleased to approve the following awards in recognition of gallantry displayed in flying operations against the enemy:—

DISTINGUISHED SERVICE ORDER.

WING CDR. T. R. VICKERS, No. 221 Squadron.—This officer formed and trained the squadron and, by his untiring efforts and skilful leadership in all conditions, he has raised it to a high standard of operational efficiency. Wing Cdr. Vickers trained 28 operational crews before operational training units began to furnish trained personnel. In August, 1941, his squadron had the highest total of flying hours of any in the command. The continued successes achieved are a direct result of this officer's inspiring leadership. He has set a magnificent example both on the ground and in the air as captain of aircraft.

BAR TO THE DISTINGUISHED FLYING CROSS.

Act. Sqn. Ldr. R. A. CHISHOLM, D.F.C., A.A.F., No. 604 Squadron.—Since being awarded the D.F.C. in March, 1941 this officer has destroyed five enemy bombers at night, thus bringing his victories to seven destroyed. By his exceptional skill, Sqn. Ldr. Chisholm has been largely responsible for the high standard of efficiency shown by his flight.

Act. Sqn. Ldr. A. D. J. LOVELL, D.F.C., No. 145 Squadron.—This officer is a fearless and skilful fighter pilot. His keenness to engage the enemy, combined with fine leadership, both in the air and on the ground, has set an inspiring example. In November, 1941, Sqn. Ldr. Lovell shot down a Junkers 88 some 35 miles off the Yorkshire coast. In January, 1942, in the same area and in difficult

Capt. Q. Tepas, senior K.L.M. pilot, and Air Comdr. H.R.H. The Duke of Kent, who decorated him with the Order of the British Empire. The honour is in recognition of Capt. Tepas' services and also as an appreciation of the excellent work by K.L.M. in the Allied cause.

Martin 166 bombers of the Royal Dutch Air Force in the East Indies. The engines are two Pratt and Whitney Twin Wasps of 1,050 h.p. each. Maximum speed 260 m.p.h. Range 2,000 miles. A crew of five is carried.

weather conditions, he intercepted another Junkers 88 and shot it down into the sea. This officer has personally destroyed at least 11 hostile aircraft and has damaged others.

DISTINGUISHED FLYING CROSS.

Sqn. Ldr. J. DARWEN, No. 152 Squadron.—This officer has led his squadron and sometimes a wing, on numerous sorties against enemy ports, industrial centres and shipping. Throughout these operations, which have called for a high degree of skill and determination, Sqn. Ldr. Darwen has displayed courageous leadership and he has undoubtedly contributed materially to the successes achieved. He has destroyed one and damaged four hostile aircraft.

Act. Sqn. Ldr. C. N. S. CAMPBELL, No. 72 Squadron.—This officer has participated in operational flying since the war began. He took part in air operations in France from September, 1939, to May, 1940. Since his return to this country, Sqn. Ldr. Campbell has performed excellent work both in operational flying and as an instructor. He has led the squadron on several sorties and his excellent leadership and initiative displayed on all occasions has contributed materially to the successes achieved.

He has also performed valuable work in connection with rescuing pilots from the sea, often remaining on patrol in the vicinity despite the presence of enemy fighters. Sqn. Ldr. Campbell has destroyed one enemy fighter and probably destroyed another.

Act. Flt. Lt. D. W. MCCORMACK, R.A.A.F., No. 615 Squadron.—This officer has carried out a large number of operational sorties, many of which have been low level attacks on objectives in Belgium and Northern France. He has at all times displayed the greatest determination in the face of enemy fire, pressing home his attacks to the utmost. On one occasion although wounded by enemy fire, Flt. Lt. McCormack descended to almost ground level to achieve success. He has set an inspiring example to all.

P/O. F. H. WILLIAMS, R.A.F.V.R., No. 152 Squadron.—This officer has participated in numerous escorts to bomber formations which have attacked enemy shipping and important land targets. These operations include three daylight raids on Brest and low level attacks on Rotterdam, Ymuiden and Alkmaar. Throughout, P/O. Williams has shown great leadership, courage and devotion to duty.

F/O. L. G. BETTINSON, R.A.F.V.R., No. 58 Squadron.—By his reliability and hard work, F/O. Bettinson has relieved his flight commander of all navigational preparation for sorties undertaken by the flight. His bombing skill has been of a high standard, while his thoroughness and coolness under heavy enemy fire have been exceptional. F/O. Bettinson's sound knowledge of electricity in general and of the bombing gear in particular has often enabled him to rectify faults while in the air which would otherwise have caused a failure of the whole operation. This officer trains all new navigators to the squadron and accompanies them on their first few operational missions.

P/O. G. C. ANDREW, R.A.F.V.R., No. 57 Squadron.—One night in August, 1941, P/O. Andrew was the navigator of an aircraft which attacked Hanover. Nearing Groningen, the aircraft was attacked by an enemy fighter. The rear gunner was killed and the aircraft sustained severe damage; the wireless set was put out of action, the alternators and air-speed indicators failed, and the aircraft was difficult to control.

Despite all this, by the officer's exceptional navigational skill, the aircraft was flown back to its base where a safe landing was made. P/O. Andrew has participated in numerous operational missions and has always displayed a high standard of courage and efficiency.

W/O. I. F. B. WALTERS, No. 204 Squadron.—W/O. Walters has been employed as a pilot in this squadron since the war began and has completed over 800 hours' operational flying. He has displayed outstanding ability in every sphere and, by his keenness and devotion to duty, he has contributed materially to the successes obtained.

DISTINGUISHED FLYING MEDAL.

Sgt. B. L. SMITH, No. 37 Squadron.—This airman has participated in operational sorties as first wireless operator over Germany, Tripolitania, Cyrenaica, Syria, Greece and the Dodecanese. Sgt. Smith has shown exceptional keenness and skill, which have earned for him the entire confidence of the members of the crews with whom he has flown.

Sgt. J. P. FARROW, R.N.Z.A.F., No. 408 (R.C.A.F.) Squadron.—One night in January, 1942, this airman was the pilot of an aircraft which bombed Emden. The aircraft was subsequently attacked and badly damaged by the fire from two enemy fighters. Sgt. Farrow received a slight wound in the leg, and the remaining members of the crew were seriously wounded. In the face of a harassing situation, Sgt. Farrow ordered the crew to abandon aircraft.

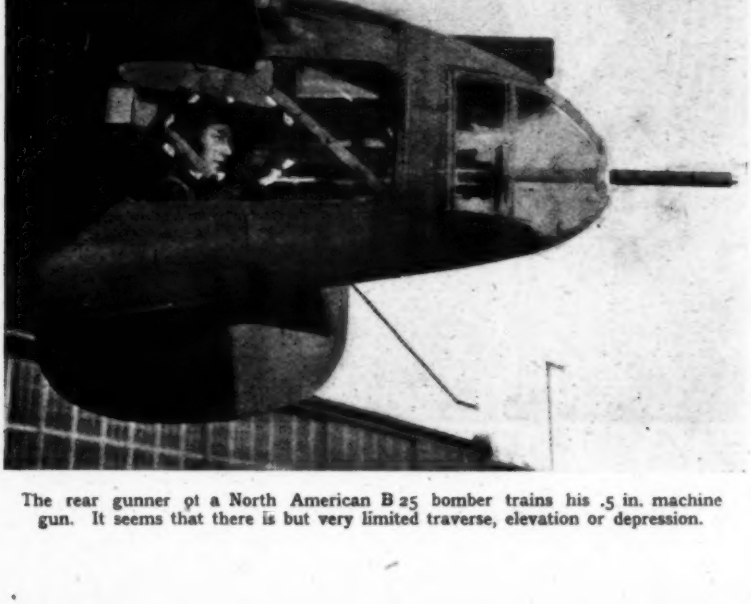
Unaware that his message had not been received, as the intercommunication system had broken down, and believing himself to be alone in the aircraft, he finally evaded his attackers and set an approximate course for England. Flying a badly damaged aircraft, on a dark moonless night, and with no instruments to aid him, Sgt. Farrow eventually reached this country, where he made a safe landing with the under-carriage retracted. By his skill and resolution he saved both his aircraft and, unknowingly, his wounded crew.

This airman has participated in many operational missions, and has always shown courage and tenacity worthy of high praise.

Sgt. E. W. BRIGGS, No. 15 Squadron. Sgt. M. S. PEPPER, No. 15 Squadron.—One night in January, 1942, Sgts. Briggs and Pepper were wireless operator and flight engineer respectively of an aircraft which carried out a successful operation against Munster. On leaving the target area, the aircraft was caught in a belt of searchlights and attacked by enemy fighters. During the first attack Sgt. Briggs was wounded in the leg. Despite considerable pain and loss of blood, he coolly continued his wireless duties until the aircraft reached this country.

Sgt. Pepper was wounded in the hand and knee, but he bravely made his way to the astro-dome, where, although suffering much pain, he rendered most valuable assistance to his pilot by directing the necessary avoiding action through a succession of attacks. He thus played a great part in the safe return of the aircraft to this country.

Air Sgt. C. JEFFRIES, S.A.A.F., No. 12 Squadron.—This airman has participated in many bombing raids, including eighteen in the Western Desert. He was originally employed as an air gunner, but later carried out the duties of observer. Although not previously trained as observer, Air Sgt. Jeffries has ably carried out all the duties assigned to him. His navigation is good and his bomb aiming excellent. He has set a splendid example to other observers and gunners, who often seek his advice.



The rear gunner of a North American B 25 bomber trains his .5 in. machine gun. It seems that there is but very limited traverse, elevation or depression.

Roll of Honour

Air Ministry Casualty Communiqué No. 106.

THE Air Ministry regret to announce the following casualties on various dates. The next-of-kin have been informed. Casualties reported "in action" are due to flying operations against the enemy; "on active service" includes ground casualties due to enemy action, non-operational flying casualties, fatal accidents and natural deaths.

Royal Air Force

KILLED IN ACTION.—Sgt. E. R. Carter; Sgt. K. Connel; Sgt. J. B. Dewar; Sgt. C. C. Gibson; Sgt. J. F. Hemus; Sgt. S. H. Jackson; Sgt. R. P. Manwaring; Sgt. E. W. Sterling; Sgt. D. A. Watson; Sgt. W. Williams.

PREVIOUSLY REPORTED MISSING BELIEVED KILLED IN ACTION, NOW PRESUMED KILLED IN ACTION.—Sgt. J. Diggory; Sgt. D. F. Hawkes; Sgt. T. E. Hyde; P/O. J. C. Jenkins; Flt. Sgt. R. Jopling; Sgt. J. C. Newlands; Act. Wing Cdr. N. E. W. Pepper, D.F.C.; P/O. K. E. A. Savage; Sgt. W. B. M. Smyth; Sgt. R. T. Stephens; P/O.

F. Turner; Sgt. D. A. Wilson; P/O. R. S. Wilson.

PREVIOUSLY REPORTED MISSING, NOW PRESUMED KILLED IN ACTION.—Sgt. H. T. Archer; P/O. P. B. Ashby; P/O. J. A. Basham; Flt. Sgt. T. Beattie, D.F.M.; Sgt. T. Beattie; Sgt. A. H. Bird; P/O. W. W. Burgon; Flt. Sgt. B. Crocker; Sgt. J. A. Donovan; Sgt. P. C. Eyre; Sgt. D. F. Gibson; Sgt. P. W. Goodwin; Sgt. H. Gretton; Flt. Sgt. R. W. Grocock; Sgt. C. Hodkinson; Sgt. J. F. Hughes; Sgt. M. G. Jackson; Sgt. J. A. B. Jamieson; Sgt. J. A. H. Jenks; Sgt. C. G. Lee; Sgt. T. McGill; Sgt. D. H. McPhail; Flt. Sgt. G. C. Marsh; P/O. L. J. Moore; P/O. J. J. Notidge; P/O. T. P. Pratt; Act. Flt. Lt. T. G. F. Ritchie; Sgt. J. B. Seden; P/O. G. H. Seeley; Sgt. M. S. Soames; Sgt. W. A. Smallbone; F/O. J. G. R. Sturrock; F/O. J. R. G. Sutton; Act. Sqn. Ldr. G. R. Taylor, D.F.C.; P/O. H. C. Tonge; Sgt. A. C. Willis; Sgt. N. S. Wilson; Sgt. K. P. Withyman.

WOUNDED OR INJURED IN ACTION.—Flt. Lt. J. W. Appleton; Sgt. W. L. Barcroft; Flt. Sgt. T. H. Bigmore; Sgt. J. Gibson.

DIED OF WOUNDS OR INJURIES RECEIVED IN ACTION.—Sgt. E. C. Hoskins; P/O. S. N. Muhart; F/O. B. E. L. Odhams.

MISSING, BELIEVED KILLED IN ACTION.—F/O. J. H. M. Davies, D.F.C.; F/O. D. V. Gilmour; Flt. Sgt. R. M. Hannan; Sgt. L. Harding; Sgt. S. Jamieson; P/O. D. S. Martin; Wing. Cdr. J. C. Mayhew; Sgt. W. H. Poole; P/O. A. J. Pyle; LA/C. W. G. Sheean; Act. Flt. Lt. R. P. Stevens, D.S.O., D.F.C.

MISSING.—F/O. P. O. D. Allcock; Sgt. E. W. Armer; Sgt. H. Ashton; Sgt. J. R. Boland; F/O G. Bunce; Sgt H. Carter; Sgt. J. A. Chadawy; P/O. R. N. Chancellor; Sgt. J. Collins; Sgt. J. R. Conn; Sgt. R. L. Cooke; Sgt. J. W. Durrant; Sgt. R. W. Ebsworth; Sgt. G. G. Fell; Sgt D. Ferguson; Sgt. D. A. Ferguson; Sgt. M. J. Fitzgerald; Sgt. G. J. W. Fleming; Sgt. I. A. Flower; Sgt. L. H. Fowler; Sgt. H. D. Grey; Sgt. D. E. Hall; Sgt. S. E. Hedin; Sgt. K. A. Jeffreys; P/O. M. Lee; Sgt. J. F. Liles; Sgt. H. L. Loveday; Sgt. A. McLevy; Sgt. N. J. Mills; Sgt. P. G. Osman; Act. Sqn. Ldr. H. Parkinson; Sgt. J. Pickup; P/O. E. D. Rawes; F/O. A. T. Read; Sgt. R. Shearer; Sgt. L. R. Townsend; Sgt. E. W. Walters; Sgt. R. L. Watts; Flt. Sgt. D. E. Webb; Sgt. F. A. White; Flt. Sgt. W. Wooldridge; Sgt. W. J. Young.

KILLED ON ACTIVE SERVICE.—Sgt. K. G. Boulton; Act. F/O. D. G. Buchanan; Act. Col. T. B. Buxton; F/O. K. C. Cooke; Sgt. M. B. Cuke; LA/C. M. Daly; A/C.2 G. Dandy; F/O. A. T. Darling; LA/C. H. Finn; Sgt. M. H. A. Genney; Sgt. J. J. Green; A/C.1 J. Heyworth; P/O R. J. Hopkins; LA/C. O. H. Jones; Sgt. H. G. Kelly; Act. Flt. Lt. A. W. Lacey; A/C.1 L. R. Lintott; P/O. D. C. Littlewood; Flt. Lt. T. M. Maguire; P/O. D. F. Meacham; Flt. Sgt. W. L. Oldnall; Sgt. R. J. Peach; A/C.2 H. T. Phillips; Sgt. B. Pinpend; Sgt. N. F. Rowe; A/C.2 W. K. Stephens; Sgt. F. J. Sunley; LA/C. (Cadet) T. P. Watt; Act. Sqn. Ldr. R. G. Williams, D.F.C., A.F.M.

PREVIOUSLY REPORTED MISSING, BELIEVED KILLED ON ACTIVE SERVICE, NOW PRESUMED KILLED ON ACTIVE SERVICE.—Act. Flt. Lt. W. T. D. Windham.

WOUNDED OR INJURED ON ACTIVE SERVICE.—F/O F. A. Bidgood; Sgt. A. J. Brogan; P/O P. N. Davey; Act. Flt. Lt. F. S. Davies; A/C.1 T. L. James; Sgt. J. Lee; A/C.2 C. Lutey; Sgt. S. Shepherdson; LA/C. G. O. Smit; A/C.1 N. Turner; LA/C. C. A. Wood.

DIED OF WOUNDS OR INJURIES RECEIVED ON ACTIVE SERVICE.—Cpl. H. J. A. Clare; Act. Sqn. Ldr. J. H. Van.

DIED ON ACTIVE SERVICE.—W/O. A. Ashford; Sgt. A. T. Baber; Cpl. H. J. Browning; Sgt. T. Clarke; A/C.2 W. H. Clayton; LA/C. S. Kelly; Sgt. R. Kirkup; Col. P. McGlone; LA/C. W. J. Marchant; P/O. P. F. Murphy; A/C.2 S. W. Northy; Act. Flt. Lt. B. S. B. Plunket; Cpl. G. Reore; LA/C. L. Wells.

Royal Australian Air Force

KILLED IN ACTION.—P/O. R. W. Drury.

PREVIOUSLY REPORTED MISSING, BELIEVED KILLED IN ACTION, NOW PRESUMED KILLED IN ACTION.—Sqn. Ldr. D. H. Campbell.

PREVIOUSLY REPORTED MISSING, NOW PRESUMED KILLED IN ACTION.—Sgt. A. E. R. Barton; Sgt. A. Milne; P/O. W. Brine.

WOUNDED OR INJURED IN ACTION.—P/O. G. L. Angus; Sgt. J. F. Jennings; Flt. Lt. C. R. McKenny.

MISSING, BELIEVED KILLED IN ACTION.—Sgt L. J. Abbott; Sgt. J. H. Pott.

MISSING.—Sgt. L. Brown; Sgt. A. H. Ferguson; Sgt. W. A. McAllen; Sgt. P. F. Matthews; Sgt. D. Scott.

KILLED ON ACTIVE SERVICE.—P/O. B. L. Sturdee.

DIED OF WOUNDS OR INJURIES RECEIVED ON ACTIVE SERVICE.—Flt. Lt. F. W. Hordern.

Royal Canadian Air Force

KILLED IN ACTION.—Sgt. P. L. Gurd; Sgt. W. T. Lee; Sgt. J. M. McKenzie; P/O. F. H. Sutton; Sgt. J. C. Tomlin.

PREVIOUSLY REPORTED MISSING, BELIEVED KILLED IN ACTION, NOW PRESUMED KILLED IN ACTION.—P/O. C. F. Hart.

PREVIOUSLY REPORTED MISSING, NOW PRESUMED KILLED IN ACTION.—Sgt. H. H. Boland.

MISSING, BELIEVED KILLED IN ACTION.—Sgt. T. J. Arsenault; P/O. W. F. Hull; P/O. R. F. Patterson.

MISSING.—P/O. G. A. Chamberlain; Sgt. B. J. Dermody; Sgt. J. A. Foster; Sgt. M. H. Heinish; Sgt. T. D. Holden; Sgt. E. E. Nelson; Sgt. J. L. Ruthven.

KILLED ON ACTIVE SERVICE.—Sgt. W. W. Hughes; Sgt. N. P. Julian; Sgt. R. P. Owen; Sgt. K. F. Peters; Sgt. P. R. Roach.

PREVIOUSLY REPORTED MISSING, BELIEVED KILLED ON ACTIVE SERVICE, NOW PRESUMED KILLED ON ACTIVE SERVICE.—Sgt. M. J. C. Craig.

WOUNDED OR INJURED ON ACTIVE SERVICE.—F/O. R. E. Chandler.

DIED OF WOUNDS OR INJURIES RECEIVED ON ACTIVE SERVICE.—Sgt. L. D. Kippan.

Royal New Zealand Air Force

PREVIOUSLY REPORTED MISSING, BELIEVED KILLED IN ACTION, NOW PRESUMED KILLED IN ACTION.—Sgt. H. C. McL. Haselden.

PREVIOUSLY REPORTED MISSING, NOW PRESUMED KILLED IN ACTION.—Sgt. C. H. Robson.

WOUNDED OR INJURED IN ACTION.—P/O. S. H. Gunning.

MISSING, BELIEVED KILLED IN ACTION.—Sgt. D. L. Todd.

MISSING.—Act. Flt. Lt. E. G. Edmunds; Sgt. T. C. B. Patterson; Act. Flt. Lt. I. W. Terry.

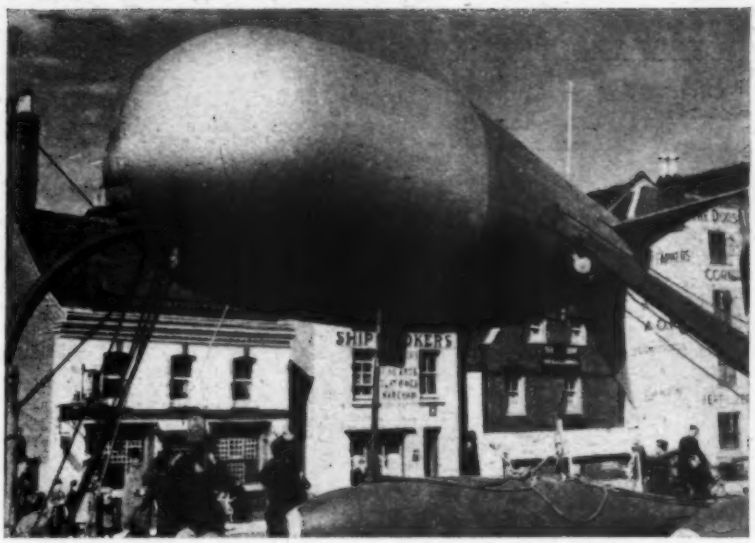
KILLED ON ACTIVE SERVICE.—P/O. S. A. Crisp; P/O. I. C. Grant.

South African Air Force

KILLED IN ACTION.—Air Sgt. N. H. Petterson; Lt. J. A. Smith.

MISSING, BELIEVED KILLED IN ACTION.—2/Lt. M. C. Meadows.

MISSING.—2/Lt. J. McR. Barclay; 2/Lt. P. C. De-Mellion; 2/Lt. L. N. Evans; Air Sgt. M. V. Fleming; Air Sgt. S. R. Galloway; Air Sgt. Greenburgh; 2/Lt. D. Harris; Lt. O. C. Hajem; Air Sgt. A. Kahn; Lt. G. A. Marshall; 2/Lt. N. Sandilands; Lt. R. E. Stanford; Lt. L. A. Stone; Lt. W. L. Wood.



Travelling Balloon Barrage. Kite balloons are flown from ships in convoy to deter dive-bombers from coming too low. The ribbing underneath the balloon is an elastic device to keep the internal pressure constant.

Officers and men of the Eighth Army and R.A.F. in Libya attend an impromptu church service conducted by an R.A.F. padre in the Desert.

SERVICE AVIATION

Casualty Communique No. 109

Royal Air Force

KILLED IN ACTION.—Sgt. C. S. H. Bayford; A/C.2 R. Cunningham; Sgt. J. H. Dunn; Sgt. A. J. Forth; Flt. Lt. D. J. Fletcher; Sgt. C. E. Gailey; Sgt. D. S. J. Harris; P/O. A. W. Hutton; P/O. C. Ludwig; Cpl. J. H. Martin; Flt. Sgt. H. F. Mitchell; Sgt. C. S. Mort; P/O. I. Paul; P/O. C. B. Payne; Flt. Lt. J. K. Ross, D.F.C.; Sgt. T. W. Sherratt; Sgt. J. H. Tolman; Sgt. J. R. Stansfield; A/C.2 W. Watson.

PREVIOUSLY REPORTED MISSING, BELIEVED KILLED IN ACTION, NOW PRESUMED KILLED IN ACTION.—Sgt. E. Chesterman; Sgt. L. E. D. Lindsay; Sgt. G. E. Powell; Sgt. C. L. Ray.

PREVIOUSLY REPORTED MISSING, NOW PRESUMED KILLED IN ACTION.—P/O. R. D. Allen; Sgt. J. E. Austin-Johnston; P/O. S. Baker; Sgt. R. B. Chrisp; Sgt. V. A. Davis; P/O. N. Dotchin; P/O. E. C. Elder; Sgt. R. F. S. Ford-Hutchinson; Sgt. G. Harvey; Sgt. F. Hewitson; Flt. Sgt. R. W. J. Hill; P/O. P. B. Hodgson; Sgt. S. J. Holt; Sgt. W. P. James; F/O. R. K. Keating; Sgt. R. H. Kenvin; Squ. Ldr. G. S. King; Act. F/O. J. F. P. J. McKenna; P/O. Sir I. W. Mac Robert; Act. Sqn. Ldr. G. O. Mills; Sgt. D. Owen; Sgt. J. M. Pilbeam; Sgt. R. T. Philp; P/O. E. D. Pockney; Sgt. L. T. Rice; Sgt. R. W. Smale; Sqn. Ldr. E. U. G. Solbe; Sgt. G. Summers; Sgt. E. C. Stevens; Sgt. A. Turner; Sgt. P. M. Wakefield; Sgt. N. H. Whittaker; Sgt. D. G. Willis; Sgt. D. J. Wyatt; Sgt. F. W. York.

WOUNDED OR INJURED IN ACTION.—Flt. Lt. R. A. Atkinson; Sgt. K. J. Baker; Sgt. C. R. Baxter; P/O. A. H. Gambling; Sgt. R. A. Hobbis; Flt. Lt. F. D. Hynes; Sgt. J. I. Morris; Sgt. S. M. Taylor.

DIED OF WOUNDS OR INJURIES RECEIVED IN ACTION.—Sgt. F. G. Simmonds; Sgt. E. A. Voy.

PREVIOUSLY REPORTED WOUNDED OR INJURED IN ACTION, NOW REPORTED DIED OF WOUNDS OR INJURIES RECEIVED IN ACTION.—Sgt. W. Paxton.

MISSING, BELIEVED KILLED IN ACTION.—A/C.1 K. W. Bennett; Flt. Lt. S. Brandt; Flt. Lt. R. V. Burbridge; P/O. A. Carter; Sgt. E. Crossley; Flt. Sgt. G. H. D. Dawson; P/O. A. G. W. Debonnaire; L.A/C. J. W. Douglas; Sgt. J. S. Gray; Sgt. K. T. Hewson; L.A/C. J. B. Hides; Flt. Sgt. G. E. Jones; Flt. Sgt. F. R. Lewis; Sgt. S. Lockett; Sgt. H. G. Lake; A/C.2 J. Robinson; Sgt. J. Short; Sgt. H. L. Southall; L.A/C. J. H. Wallace.

MISSING.—P/O. S. W. Andersen; Act. Sgt. D. Bell; Sgt. P. C. Bell; Sgt. L. Blair; Sgt. L. R. Brockett; Sgt. M. Bryan; Sqn. Ldr. T. D. Calnan; P/O. J. F. Catchpole; Sgt. W. Chalmers; Sgt. D. P. D'Arcy; Sqn. Ldr. C. R. Davies; Flt. Lt. J. A. B. Dobson; Sgt. F. Eaton; Flt. Sgt. F. R. Emery; F/O. J. Fiddes; P/O. L. J. P. Foster; Sgt. E. F. W. Fowler; Sgt. H. Freeman; P/O. R. A. F. Frew; Sgt. A. G. Gooch; Sgt. A. S. Greenwood; P/O. P. J. Halliday; Sgt. R. F. J. Henley; Act. Flt. Lt. J. H. Higgleton; Sgt. T. F. Houldsworth; Sgt. K. T. Jackson; Flt. Sgt. R. F. R. James; Sgt. S. H. James; Sgt. W. Jamison; Sgt. M. G. Kipling; Sgt. W. H. Lamond; Sgt. P. F. Lill; Sgt. R. M. D. McLeod; Sgt. N. Maddox; Sgt. P. C. G. Maflin; Sgt. J. Marsland; Sqn. Ldr. S. A. Middleton, D.F.C.; Sgt. C. E. Newman; P/O. K. B. Orr; Sgt J. A. Orton; Sgt. H. F. D. Parsons; F/O. J. Paterson; Sgt. P. D. Randall; Sgt. L. F. Redfern; Sgt. D. H. Roberts; Sgt. J. Roberts; Act. F/O. E. C. Scholefield; Sgt. A. V. W. Sherwin; F/Q. D. L. Skinner, D.F.C.; Flt. Sgt. G. R. Smith; Act. Flt. Lt. F. Spikins; Sgt. J. H. Taylor; Sgt. H. J. Toski; Sgt. J. Wilson; Sgt. A. R. Wren.

MISSING, BELIEVED KILLED ON ACTIVE SERVICE.—Sgt. G. Gibson; Cpl. T. Hazlewood; Sgt. J. L. Newell; Sgt. G. R. Stookes.

KILLED ON ACTIVE SERVICE.—Sgt. L. Barker; Sgt. A. J. Browne; Sgt. R. A. Butcher; Flt. Sgt. D. Copes; Sgt. G. G. Cornes; Sgt. A. Flint; Sgt. J. E. Frith; Flt. Sgt. H. S. D. Goss; Cpl. J. Granard; Sgt. C. W. Green; L.A/C. R. F. G. Griffin; Act. Sgt. C. M. W. Howard; Sgt. T. H. Jones; Sgt. A. R. McCoy; L.A/C. F. V. Marhoff; P/O. R. G. Marland; Sgt. A. D. Matthews; A/C.1 T. Menzies; Flt. Sgt. F. T. Miniken; L.A/C. R. N. Moss; Sgt. H. Pashley; Sgt. F. Prime; Sgt. T. S. Sadler; Flt. Lt. D. E. Shorman; Sgt. G. C. Spencer; Sgt. J. A Stark; L.A/C. A. H. Sutton; L.A/C. J. R. Tomlinson; Cpl. E. B. Verney; Sgt. J. P Williams; Sgt. H. Wolstenholme.

PREVIOUSLY REPORTED MISSING, BELIEVED KILLED ON ACTIVE SERVICE, NOW REPORTED KILLED ON ACTIVE SERVICE.—Act. F/O. N. Cox; L.A/C. J. E. B. Hards; L.A/C. D. J. Laidman; L.A/C. L. Morris; Sgt. C. G. A. Tabor; L.A/C. J. Ward.

WOUNDED OR INJURED ON ACTIVE SERVICE.—Sgt. C. M. Edghill; W/O. G. A. Hughes; Sgt. J. G. Lloyd; F/O. J. H. N. Molesworth, D.F.C.; Sgt. T F. Mooney; Sgt D. Pike.

DIED OF WOUNDS OR INJURIES RECEIVED ON ACTIVE SERVICE.—L.A/C. W. J. McNicol.

DIED ON ACTIVE SERVICE.—A/C.2 F. H. Andrews; Act. Flt. Lt. O. M. Baldwin, D.F.C.; Act. Flt. Lt. M. L. P. Bartlett; L.A/C. T. I. Bessey; A/C.2 J. R. Blackshaw; Sgt. M. Comer; A/C.1 A. O. Daly; Sqn. Ldr. C. J. W. Darwin, D.S.O.; L.A/C. M. Edington; L.A/C. A. E. Evans; L.A/C. F. S. Hailes; Sgt. N. A. Hill; F/O. K. E. Langley; L.A/C. A. T. Lloyd; L.A/C. J. Nattrass; A/C.2 F. U. Pennell; L.A/C. J. J. Queenan; L.A/C. R. W. Slade; A/C.2 J. T L. Thomas; L.A/C. C. Watts; Sgt. M. G. Yonge.

PREVIOUSLY REPORTED MISSING, NOW REPORTED PRISONER OF WAR.—Sgt. D. A. Wright.

Royal Australian Air Force

KILLED IN ACTION.—P/O. A. McN. Christie; P/O. J. L. S. Willox.

PREVIOUSLY REPORTED MISSING, BELIEVED KILLED IN ACTION, NOW PRESUMED KILLED IN ACTION.—P/O. W. W. Bell-Towers.

MISSING.—Act. Sgt. J. C. Coldrey; F/O. D. A. Dowie; Sgt. R. A. Nitschke; Flt. Lt. J. C. Ramshaw; Sgt. G. T. Whiter; Sgt. S. M. Wilson.

KILLED ON ACTIVE SERVICE.—Sgt. C. E. Gilmour; Sgt. M. E. Kent; Sgt. W. T. McMillan.

Royal Canadian Air Force

KILLED IN ACTION.—Sgt. C. H. Bumstead.

PREVIOUSLY REPORTED MISSING, BELIEVED KILLED IN ACTION, NOW PRESUMED KILLED IN ACTION.—Sgt. G. W. Jeffrey.

PREVIOUSLY REPORTED MISSING, NOW PRESUMED KILLED IN ACTION.—Sgt. H. R. F. Johnston; Sgt. J. G. Rogers; P/O. P. E. Snyder; Sgt. L. A. Stock.

DIED OF WOUNDS OR INJURIES RECEIVED IN ACTION.—P/O. F. J. W. Saunders.

MISSING, BELIEVED KILLED IN ACTION.—Sgt. G. N. Fullerton; P/O. V. V. Havlicek; Sgt. R. H. McMillan.

MISSING.—Sgt. W. R. Gates; P/O. D. S. King; Sgt. W. R. Pick; Sgt. M. M. Waite.

KILLED ON ACTIVE SERVICE.—Sgt. J. B. Gayfer; Sgt. J. B. R. Lalonde; Sgt. O. B. Lefurgey; Sgt. W. A. Robertson; Sgt. P. Wityck; Sgt. H. Wolf.

PREVIOUSLY REPORTED MISSING, BELIEVED KILLED ON ACTIVE SERVICE, NOW REPORTED KILLED ON ACTIVE SERVICE.—Sgt. J. R. Sullivan.

Royal New Zealand Air Force

KILLED IN ACTION.—P/O. A. L. Smiley.

WOUNDED OR INJURED IN ACTION.—P/O. S. E. Scales.

MISSING.—Sgt. J. F. Lawthwaite; P/O. J. G. Lomax.

KILLED ON ACTIVE SERVICE.—P/O. J. G. Castling; P/O. J. G. Irvine; Sgt. P. N. Shaw; Sgt. A. J. Wilson.

South African Air Force

WOUNDED OR INJURED IN ACTION.—Air Sgt. R. Addison; Air Sgt. P. J. Coetsee.

MISSING, BELIEVED KILLED IN ACTION.—Lt. J. S. Iddeson.

MISSING.—Cpl. J. M. Abrahams; Act. W/O. N. H. Romain; Air Sgt. A. Zamek.

DIED ON ACTIVE SERVICE.—Air Sgt. W. Conyns.

Indian Air Force

KILLED ON ACTIVE SERVICE.—P/O. K. P. Namgyal Maharaj Kumar.

Early intruder. An impression by Robert Aitchen of an early dawn attack by a Hurricane on an enemy convoy.